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NATIONAL ACADEMIES AND THE PROGRESS OF RESEARCH

I. THE WORK OF EUROPEAN ACADEMIES

THE Academy of Plato, who bequeathed to his followers the walled garden and appointments in the place named after the hero Hekademus, was at once a school of instruction and a society for the development of new knowledge. Here he discussed his philosophy with associates and students, while it was still in the making, thus bringing them under the stimulating influence of fresh thought, developing and expanding from day to day. Writing of the Old Academy, which included the schools of Plato and his immediate successors, Cicero remarks:

> Their writings and method contain all liberal learning, all history, all polite discourse; and besides they embrace such a variety of arts, that no one can undertake any noble career without their aid. . . . In a word the academy is, as it were, the workshop of every artist.[1]

The Old Academy was thus the predecessor of our modern academies of science and of our universities as well. Its world-wide influence, while of course primarily due to the brilliant thinkers of the day, may certainly be ascribed in part to the fact that its instruction was given in an atmosphere charged with the stimulus of original thought and constantly broadening ideas. The great success of the German universities, and the outflow from them of the spirit of research into every phase of German life and thought, is undoubtedly due in the largest measure to the application of this principle. Fortunately for the intel-

[1] Cicero, "De Fin.," Vol. 3, as quoted in the Encyclopædia Britannica, 11th edition, Vol. 1, p. 106.

lectual advancement of the United States, the recognition of its importance has already permeated most of our advanced schools, and is rapidly gaining ground in the minds of their governing boards of trustees.

Aristotle, called by Plato "the mind of my school," came from a family of physicians, and thus inherited a taste for experimental knowledge. To him we owe the beginnings of exact science and the organization of research on a large scale. Thanks to his influence with his pupil Alexander the Great, he was able to command the immense sum of eight hundred talents for the purchase of books and other expenses involved in the preparation of his treatise on zoology. More than this, a thousand men throughout Asia and Greece studied under his direction the life and habits of birds and beasts, fishes and insects.[2] The territories conquered by Alexander were carefully surveyed, by measuring the position of terrestrial objects with respect to stars.[3] Although Aristotle maintained the fixity of the earth, and supposed comets and the Milky Way to be in its higher atmosphere, his reasoning in many astronomical problems was sound, as when he concluded that the earth must be spherical because its shadow on the eclipsed moon is always curved.[4] Thus his studies of natural science foreshadowed the work of the present-day investigator and led to the most far-reaching results.

[2] Wheeler, "Alexander the Great," p. 37. The strict accuracy of these assertions, which were made by several classical authors, is questioned by Grote and also by Humboldt, who nevertheless concede that Aristotle received from both Philip and Alexander the most liberal support in procuring immense zoological material from Grecian territories and in the collection of books. "Cosmos," Sabine's trans., Vol. II., p. 158.

[3] Bossut, "Histoire des Mathématiques," Vol. I, p. 116.

[4] *Ibid.*, p. 117.

After his time a gradual division of labor ultimately separated investigations in natural science from the speculations of the philosophers. In Sicily, Egypt and the islands of the Mediterranean true scientific research, in the strictly modern sense, developed with remarkable rapidity, while in the old Lyceum at Athens the philosophy of reasoning and dialectics, caring little for physical causes, was devoted exclusively to the soul.

A deep-seated belief that the senses are deceptive, and the natural impatience of the Greeks, inclining them toward reasoning and speculation rather than the slow and laborious processes of observation and experiment, had first to be overcome.[5] But in the third century B.C. the greatest geometer of antiquity, Archimedes, taught at Syracuse a system of astronomy closely resembling that of Copernicus, founded the science of mechanics in his treatise "De Æquiponderantibus," and devised some of the fundamental experimental methods of modern physics. At the same period Aristarchus of Samos made a first determination of the distance of the sun from the earth and held that "the center of the universe was occupied by the sun, which was immovable, like other stars, while the earth revolved around it."[6] This view was also taught by Seleucus the Babylonian, but it was rejected by Ptolemy, the most celebrated astronomer of his day.

Of all the ancient prototypes of the modern academy, the great Museum of Alexandria holds the first place. Founded by Ptolemy Soter, whose preference would have confined its work to the moral and political sciences, its scope soon expanded under the influence of Ptolemy Phila-

[5] Weber, "History of Philosophy," Thilly's trans., p. 133 *et seq.*

[6] See Humboldt, "Cosmos," Vol. II., p. 309, and notes, p. cix.

delphus and the pressure of circumstances, until it embraced the whole field of knowledge.[7] Here almost all of the important results of Greek science were obtained in a period covering nine centuries. The museum established by Ptolemy was an extensive palace, housing the brilliant company of scholars and investigators gathered together from all parts of Greece. As a state institution, endowed with special revenues, it was under the direction of the government, which appointed its head. This, in accordance with the traditions of the day, was a priest, whose ecclesiastical office, and even the name of the museum itself, gave a kind of religious character to the institution,[8] though it subsequently became purely secular.

Ptolemy Philadelphus collected strange animals from many lands, and sent Dionysius on exploring expeditions to the most remote regions.[9] But while the investigators of the museum doubtless profited by these collections and explorations for their studies in natural history and geography, Matter finds no evidence that at this period the museum possessed either a distinct natural history collection or a zoological park,[10] though the study of medicine was encouraged, and a great art collection was developed.

The rising tide of science soon brought all the material requisites of research, supplementing the great library of 700,000 volumes by the instruments, laboratories and collections demanded by the astronomer, the physicist and the student of biology. A botanical garden, a zoological menagerie, an anatomical laboratory and an astronomical observatory in the Square Porch, provided by Ptolemy Euergetes with an equinoctial and a solstitial armillary, stone quadrants, astrolabes and other instruments, illustrate the nature of the extensive equipment provided. The work of the Alexandrian school thus continued to grow, until it embraced all of natural and physical science, medicine, mathematics, astronomy and geography, history, philosophy, religion, morals and politics. It is significant that an institution which in many respects would be regarded as a model to be striven for to-day, should have developed at so early a period in the history of civilization.[11]

To the Alexandrian school we owe the "Geometry" of Euclid, and his treatises on "Harmony," "Optics" and "Catoptrics"; the hydraulic screw and some of the mathematical and physical discoveries of Archimedes of Syracuse, who spent part of his time in Egypt; the mathematical, astronomical, geographical and historical investigations of Eratosthenes, who first endeavored to determine the circumference of the earth by measuring the difference of latitude and the distance between Alexandria and Syene, and wrote on such subjects as the geological submersion of lands, the elevation of ancient sea-beds, and the opening of the Dardanelles and the Straits of Gibraltar; the "Conic Sections" of Apollonius; the mathematical and astronomical researches of Hipparchus, whose discovery of the precession of the equinoxes was based on observations made five hundred years previously by Timochares at Alexandria; and the great "Syntaxis" of Ptolemy, translated as the "Almagest" by the Arabians, which stood as a commanding authority in Europe for nearly fifteen hundred years. Founded on the geocentric hypothesis, the "Almagest" is nevertheless

[7] Matter, "Histoire de l'Ecole d'Alexandrie," 2d ed., Vol. II., Introduction, p. v.

[8] *Op. cit.*, Vol. I., pp. 87 and 96.

[9] *Ibid.*, p. 158.

[10] *Ibid.*, p. 159.

[11] Draper, "Intellectual Development of Europe," Vol. I., p. 188.

replete with astronomical methods and observations of the widest range and significance, and includes Ptolemy's discovery of the lunar evection, a rough determination of the distance from the earth to the sun, a masterly discussion of the motions of the planets, and a catalogue of 1,022 stars. These remarkable advances, which include only a fraction of the enormous scientific product of the Alexandrian school, were supplemented by equally striking contributions to literature and art. Philology, criticism and the history of literature became sciences, while the coming together of Buddhists, Jews, Greeks and Egyptians, with the most diverse beliefs, led to the development of comparative theology. Of the literary works of the Alexandrian school the Septuagint and the poems of Theocritus are perhaps the most widely known.[12]

The rising power of Rome, which finally made of Alexandria a mere provincial town, was coincident with the decline of Greek intellectual life. In this paper only the more significant epochs in the development of academies can be mentioned, and we must pass over the work of the immediate successors of the Alexandrian school in Rome and Byzantium, and the achievements of Arabian science in Africa, Spain and Persia. In 1453, by the fall of Constantinople, where Greek scholars had preserved, in antiquated and pedantic form, the literary and philosophical traditions of the Alexandrian age, Italy was once more raised to its old position of "Magna Græcia." Some years earlier the scholar and ambassador Pletho, aided by Cosimo de Medici, had established a Platonic academy in Florence. Under this stimulus, and the influence of the Greek refugees, philosophy became popular, and Greek was widely studied. The voyages of Columbus, Da Gama and Magellan, and the astronomical achievements of Tycho Brahe, Copernicus, Kepler and Galileo reawakened the appreciation of scientific research and its possibilities. Leonardo da Vinci continued the work of Archimedes and the Alexandrian school in optics, mechanics and other branches of physics, Vesalius established human anatomy on a firm foundation, and Harvey proved the theory of the circulation of the blood. It is not surprising that under such conditions academies of literature and science should multiply in Europe.

Among the earliest Italian academies were the academy of history, philology and archeology, founded in Rome by Pomponio Leto in 1457; the Accademia di S. Luca, devoted to the fine arts, established in 1577; and the Accademia della Crusca, founded in 1582, which has published several editions of its great Italian dictionary.[13] In addition to these organizations seriously devoted to the encouragement of literature and the arts, a host of imitations sprang up all over Italy during the sixteenth century. Perhaps the gaiety of their proceedings was considered to find sufficient warrant in the splendid suppers offered to the academy of Pomponio by the wealthy German Goritz, regarding which Ginguéné[14] quotes the remarks of an earlier authority:

> Ainsi, dit avec un juste sentiment de regret, le bon Tiraboschi, ainsi parmi les verres et les jeux d'esprit, on cultivait joyeusement les lettres, et les plaisirs mêmes servaient à en encourager et à en ranimer l'étude.

According to Libri,[15] Leonardo da Vinci founded and directed the first scientific and experimental academy established in Italy.

[12] See the works of Matter, Montucla, Bossut, Whewell, Draper and Weber.

[13] Carutti, "Breve storia dell'Accademia dei Lincei," p. 157.

[14] Ginguéné, "Histoire literaire d'Italie," Vol. 7, p. 353.

[15] "Histoire des sciences mathématiques en Italie," Vol. 3, p. 30.

Another early academy devoted to the pursuit of science was the Academia Secretorum Naturæ of Naples, which dates from 1560.

Of special interest to the modern investigator is the Accademia del Cimento, which possessed a large collection of physical instruments, many of which are now preserved in the Galileo Museum at Florence. The "Saggi di Naturali Esperienze" made in the laboratories of this institution is an admirably illustrated account of early academic activities. The experiments, which are described in great detail, with the aid of excellent woodcuts of instruments, are in some cases attributed to Galileo, Torricelli and other investigators, and in other cases are said to have been first performed in France. They include a wide variety of subjects, such as the effects of artificial freezing on various waters, wines, acids and oils, the compression of liquids, various phenomena in a vacuum, the electrical properties of amber, and the motion of projectiles.

This important volume was published in 1666, ten years after the establishment of the Academy, which lasted only during this period. The one great Italian academy of science which still survives is the Accademia dei Lincei, founded by Federico Cesi in 1603. His vast plans of organization for the Academy, resembling those of the religious and military orders of the day, are described in an unpublished work entitled the "Linceografo." The Academy was to comprise establishments in the four quarters of the world, where the members would lead a common life in the midst of libraries, museums, observatories, laboratories and botanic gardens, provided with every requisite means of research, and in constant communication with the other constituent bodies of the organization. The name *Lincei*, or Lynx-eyed, was taken in recognition of the reputation of the lynx for extreme penetration of vision, "*vedendo non solo quello che è di fuori, ma anche ciò che dentro si asconde.*"[16]

After a stormy period of youth, during which Cesi and his three fellow organizers underwent many vicissitudes, the Academy was vigorously revived in 1609. Two years later, to its lasting renown, it was joined by Galileo, whose earliest telescopic discoveries had just been made. Under this stimulus, and aided by the widespread interest in Galileo's work, the Academy now advanced rapidly. While devoting special attention to the mathematical and physical sciences, it did not neglect the cultivation of literature, counting among its members historians, poets, antiquarians and philologists. Its cosmopolitan character is indicated by the diverse nationality of its membership, which was drawn from many of the nations of Europe. An English member of this period was Francis Bacon.[17]

In November, 1612, Galileo communicated his discovery and observations of sunspots, which were published by the Academy under the title "Istoria e Dimostrazioni intorno alle Macchie Solari." The manuscript of this epoch-making discovery is still preserved by the Academy. This was followed in 1622 by his "Saggiatore," published in great haste, to avoid interference from the Church. Two years later he demonstrated at Rome the use of the microscope, so named by Fabri, a member of the Lincei. In 1629 Galileo completed his dialogue on "Due massimi sistemi del Mondo," and proposed to go to Rome to see it through the press.

Limitations of space forbid mention of

[16] Carutti, "Breve storia dell'Accademia dei Lincei," p. 8.

[17] Carutti, *op. cit.*, p. 26.

[18] *Ibid.*, p. 28.

the memorable events of this period, in which the Academy supported Galileo in his difficulties with the Inquisition, and accepted the resignation of Valerio, who had attacked his doctrines. It was a stirring period, full of new and vigorous thought, which sharply conflicted with the traditions of a vanishing age. Led by such men as Cesi, Porta, Galileo and Colonna, the Lincei played a prominent part in the development of the scientific advance of Italy and in the cultivation of the growing love of truth which spread throughout the civilized world. But in 1830 the Academy came to a sudden end, attributed by Carutti to the withdrawal of the patronage of Cardinal Barberini.[19]

Since that date it has seen several revivals, which are described in the history from which the present notice is derived. Reconstituted under Victor Emmanuel II. in 1875 as the Reale Accademia dei Lincei, it now flourishes as the national academy of Italy. The class of physical, mathematical and natural sciences has 55 members, 55 national correspondents, and 110 foreign members. The class of moral, historical and philological sciences has 45 members, 45 national correspondents and 45 foreign members. The president belongs to one class, the vice-president to the other, and each has a secretary and an assistant secretary.[20]

The home of the Lincei in the Palazzo Corsini is admirably adapted for the purposes of an academy. The collections include an extensive library, rich in rare books and manuscripts, and a large gallery of paintings, most of which is open to the public. The annual meeting, held in the great hall of the palace, is a very impressive function, attended by the King and Queen and other members of the royal family, whose keen and intelligent interest in the work of the Academy is a powerful incentive to increased effort and broader usefulness.

A brilliant and inspiring picture of the Paris Academy of Sciences at the zenith of its development and fame may be found in the opening chapter of Merz's "History of European Thought." This Academy organized through the efforts of the far-seeing statesman Colbert, at the period when Newton was engaged in the composition of his "Principia," has probably exerted a more favorable influence on the progress of science than any other similar institution in Europe. Enjoying both the moral and financial support of the French government, and permeated by an enthusiasm for scientific research which led its members to develop the most extensive cooperative projects, it offers a pattern which other academies may well seek to imitate. Great as it remains to-day, the period in its history which deserves our most careful consideration is that brilliant epoch, at the end of the eighteenth century, when France was everywhere recognized as the leader of the scientific world.

The academicians named by Colbert held their first informal meeting in the library of the Hotel Colbert in June, 1666. In the words of Fontenelle, heaven seemed to favor the rising company, which was fortunately able to observe two eclipses within the short interval of fifteen days. The second of these was observed with the aid of an instrument devised by Huygens (who was one of the members), and perfected later by Auzout and Picart—the well-known micrometer of the astronomer.

The original group, composed wholly of mathematicians and astronomers, was soon enlarged to sixteen, through the addition of Claude Perrault, Mariotte and other well-known chemists, physicians and anatomists. Laboratories and collections were

[19] *Op. cit.*, p. 97.

[20] See revised statutes, Carutti, *op. cit.*, p. 245.

established in the Bibliothèque du Roi, and the astronomical instruments were mounted in the garden, awaiting the completion of the great observatory designed by Perrault, where some of the meetings were subsequently held. Picart undertook the measurement of an arc of the meridian which, when completed by Cassini, removed the last doubt of Newton as to the theory of gravitation. He was also sent to Denmark to determine the position of the ancient observatory of Tycho Brahe. Geographical maps were corrected and the latitudes and longitudes of a great number of points were measured. Richer went to Cayenne to determine the length of the pendulum and to make other observations. In short, the greatest activity reigned under the personal stimulus of Colbert, whose correspondence shows how large an amount of time he devoted to the interests of the Academy. Well-known names were added to the list of members, including those of Roemer, who determined the velocity of light from the eclipses of Jupiter's satellites; Cassini, the first of a remarkable lineage of astronomers; the anatomist du Verney; and the great Leibnitz.

Under Louvois, the successor of Colbert, the Academy languished, but Bignon's plan of reorganization, adopted in 1699, inaugurated a new period of progress. The Academy was provided with quarters in the Louvre, where it remained until Napoleon assigned to the Institute the former College Mazarin which it still occupies. Its unpublished memoirs were promptly printed, and were so favorably received by the public that as many as three editions were sometimes demanded. At this period a class of "associés libres" was established, to which such men as Turgot, the engineers Perronet and Belidor and Bougainville the explorer have since belonged.

During the eighteenth century the Academy attained a height only surpassed during the brilliant epoch following the Revolution. Among the important events of this century were the mathematical researches of Clairaut and d'Alembert; the expeditions of Clairaut and Maupertuis to Lapland and of Godin, Bouguer and La Condamine to Peru, for the measurement of arcs of the meridian; the similar undertaking of La Caille at the Cape, where he also determined the lunar parallax in cooperation with astronomers in the northern hemisphere; and the observations of the transits of Venus in 1761 and 1769 by Pingré at Rodrigues' Island, LeGentil in India, and Chappe in Siberia and California. The Cassinis continued their extensive astronomical and geodetic investigations in France, where the activity of astronomical research is illustrated by the fact that when Bernouilli came to Paris in 1760 he found, in addition to the original observatory, eight or ten other observatories engaged in investigation under the direction of academicians. Lalande, known as a severe critic, wrote in 1766:

> The collection of Memoirs of the Academy of Sciences is the richest storehouse of astronomical knowledge which we possess.

But the work of the Academy was by no means confined to astronomy and its sister sciences. Through the investigations of its chemists, the way was prepared for the creation of modern chemistry by Lavoisier. Réaumur, Buffon and their contemporaries were making extensive contributions to natural history, while Haüy was laying the foundations of mineralogy. At the same time Geoffroy and the three Jussieus shared with Linnæus the honor of creating the science of botany.

Under such conditions it is not surprising that the nation should turn to the Academy for assistance and guidance in many of its enterprises. Ministers, parliaments,

administrators and state assemblies often sought its aid and accepted its decisions. So commanding was its position that when all the academies were suppressed under the Revolution, it was stipulated that the Academy of Sciences should provisionally continue its functions and receive its annual revenues from the state.

As there are still those who see in a national academy a menace to true democracy, and who criticize our own National Academy on this score, the attitude of the revolutionists toward the Paris Academy is not without interest. In the report on public instruction made by Talleyrand to the National Assembly in 1791, on behalf of the committee, it was proposed to establish a national institute, to continue and extend the functions of the various existing academies.[21] In a later report on behalf of the Committee on Public Instruction, Condorcet showed that the only satisfactory method of determining the membership of such an academy is to leave the elections to the members themselves.[22] Article 298 of the Constitution, adopted August 22, 1795, declares:

> Il y a pour toute la République un Institut national chargé de recueillir les découvertes, de perfectionner les arts et les sciences.[23]

This differed from the former group of academies mainly in the unity of the academic body, which covered the whole range of knowledge (though the Académie Française was not represented), and the equality in number and privilege of the members resident in Paris and the non-resident members of the provinces.[24] Far from losing its prestige through the effects of the Revolution, the Academy of Sciences rose to its greatest success in the years following the Terror, and formed, with its sister academies, the chief connecting link between the modern democracy and the old régime.[25]

The National Institute, as thus constituted, lasted until 1803, when Napoleon Bonaparte again reorganized it. The members of the first class (Academy of Sciences) were grouped in two divisions, containing eleven sections in all. The two secretaries, no longer connected with any section, were made permanent. This organization, with no essential change, still remains in force. The law of 1803 suppressed the national associates, replacing them in the case of the Academy of Sciences by 100 correspondents (national and foreign), increased to 116 in 1899.

It is interesting to remember that Napoleon took an active part in the Academy of Sciences, of which he was elected a member in 1797. During the expedition to Egypt he invariably signed himself "Le membre de l'Institut, général en chef."[26] His appreciation of the importance of scientific research is amply illustrated by the distinguished company of investigators which he took with him on this expedition, where he organized the Institute of Egypt in Cairo, and proposed to establish an astronomical observatory.[27] The extensive and superbly illustrated report of his investigators on the antiquities of Egypt was the first great step in Egyptian archeology, leading to the brilliant labors of Champollion, Mariette and Maspero, and the dominance of the French school in Egypt even under British control.

In the great days of the First Empire began the brilliant period in the history of

[21] Hippeau, "L'instruction publique en France pendant la révolution," Vol. I., p. 102.

[22] *Ibid.*, p. 327.

[23] Simon, "Une Académie sous le Directoire," p. 39.

[24] Simon, *op. cit.*, pp. 44, 46, 50.

[25] Maury, "L'ancienne Académie des Sciences," p. 1.

[26] Simon, *op. cit.*, p. 40.

[27] "Mémoires sur l'Egypte," Paris, An. VIII.

the Academy which Merz so justly emphasizes. With such members as Lagrange, Laplace, Legendre and Cauchy in mathematics; Messier, Arago, Lalande and Delambre in astronomy; Biot, Ampère, Fourier, Fresnel, Becquerel and Regnault in physics; Berthollet, Gay-Lussac, Dulong, Dumas and Chevreul in chemistry; Cuvier, de Jussieu, Lamarck and Geoffroy Saint-Hilaire in biology, and with others equally celebrated in other fields, it is not surprising that the Academy commanded the respect and the admiration of the civilized world.

Some of the elements which have entered into the success of the Paris Academy are not difficult to recognize: The sympathy and support of such statesmen as Colbert and Napoleon, who appreciated the fundamental importance of science to the nation, as Alexander the Great and the Ptolemies had done before them; the cooperative spirit which led the members to work together for a common cause; the perfection in the hands of the academicians of the powerful mathematical methods which contributed so largely to the application and widespread usefulness of Newton's discoveries; and the popularization of science and the diffusion of the scientific spirit through the brilliant writings of Cuvier, Laplace, Buffon, Fontenelle and many others. Far from disdaining the translation of technical papers into attractive literature, these great leaders set an example which was followed hardly less effectively, though in a different manner, by Davy and Faraday at the Royal Institution. Cuvier, above all others, represented the academic system at its best. In his eloquent Éloges on the most eminent scientific men of the day, he paints a picture of scientific investigation and progress with the hand of a practised artist. The wide field of science, and the rich results flowing from the labors of investigators skilled in many departments of knowledge, has never been more admirably depicted than in the discourses of this distinguished perpetual secretary.[28]

In Germany, the division of the empire into many kingdoms, preventing the centralization which has been so important a factor in France and England, and the prevailing influence of the universities as research laboratories, where every teacher is not only a scholar but a productive investigator, have stood in the way of the development of any such national institution as the Paris Academy of Sciences.

During the eighteenth century the great men of science, including Leibnitz, Euler, Haller, Tobias Mayer, Lambert, Olbers and Alexander von Humboldt, were widely scattered, and in most cases had little to do with the universities, although these were already distinguished for classical scholarship. But by the publication of his "Disquisitiones Arithmeticæ," and the invention of his improved method of calculating planetary orbits, Gauss, of the University of Göttingen, placed himself on a level with the great French mathematicians and inaugurated a new era in German science. By the use of this method, von Zach and Olbers were enabled to recover the first of the minor planets, Ceres, which had been lost on its approach to the sun. Gauss also introduced exact science into the university curriculum, but it was through the work of Jacobi that the great school of German mathematicians was set on foot a quarter of a century later. The contemporary

[28] For the data used in this account of the Paris Academy I am largely indebted to the work of Maury, Simon, Merz and Hippeau, already cited, and especially to the article by Darboux in "L'Institut de France," Vol. 2 (Paris, 1907). See also the useful series of articles by Dr. E. F. Williams on the Paris, Berlin and Vienna Academies in the *Popular Science Monthly*.

establishment of chemical laboratories by the universities, and the widespread influence of Liebig, Mitscherlich and Wöhler, in chemistry, and of Schleiden and Schwann in botany and zoology, determined for all time the place of the German university in science. Schleiden's cell theory of plant structure and growth was the source of a long series of discoveries, which established the supremacy of Germany in physiology.[29]

In spite of the unfavorable conditions already mentioned, four great academies have nevertheless arisen in Germany, those of Berlin, Munich, Leipzig and Göttingen. Among these, partly because of the leadership of Prussia in the German empire and partly from other causes, the Berlin Academy stands foremost. Founded in 1700 as the *Societas Regia Scientarium,* through the influence of Leibnitz and in accordance with his plans, it has contributed in the highest degree to the advancement of German scholarship. Its present designation as "Akademie der Wissenschaften" indicates the broad scope of its activities. The fifty regular members are divided into two classes, each of which consists of two sections, presided over by a permanent secretary. The first class comprises the sections of physics and mathematics, the second those of philosophy and history. The secretaries preside in turn at the meetings of the separate classes, and at the general meetings, which are held monthly. Each member receives an annual stipend of 900 marks, while the secretaries are paid larger salaries. There are also two positions carrying salaries of 12,000 marks each, filled by the astronomer and the chemist of the academy, and a dozen similar pensions which may be distributed at discretion.

In the early days of its history, the Berlin Academy devoted most of its resources to the establishment and maintenance of research laboratories and museums. Its headquarters were originally in the Berlin Observatory, which was conducted under the direction of the Academy, and it also brought together an anatomical collection, a mineralogical museum, and a zoological garden. Furthermore, the chemist of the Academy conducted his researches in a chemical laboratory provided for the purpose.[30] In 1809, when the University of Berlin was established to compensate for the loss of Halle by the treaty of Tilsit, these functions of the Academy were transferred to the university and have since remained under its direction. In an interesting and important manuscript by Wilhelm von Humboldt, entitled "Ueber die innere und äussere Organization der wissenschaftlichen höheren Anstalten in Berlin," his ideas on the relationship between the academy and the newly organized university are fully set forth. Schleiermacher had defined the university as a group of students, the academy as a group of investigators: the former concerned with the diffusion of knowledge, and the stimulation of scientific research, the latter with the development of scientific problems themselves. Humboldt believed the main distinction between the two bodies to lie in their form and their relationships rather than in their work. The university always remains in close relationship with practical life and the necessities of the state, since it is engaged in the practical task of educating the youth of the nation, while the academy is concerned solely with knowledge.

When only the function of teaching and disseminating knowledge is assigned to the university and its promotion to the academy, injustice is manifestly done the former.[31]

[29] See Merz's "History of European Thought," Vol. 1, Chap. 2.

[30] See Harnack's great "Geschichte der Berliner Akademie der Wissenschaften."

[31] Paulsen, "The German Universities," trans. by Thilly and Elwang, p. 53.

Whereas the university teachers are under common bonds only in the matter of discipline, and are quite independent of one another in other respects, the academy is a society each member of which must submit his work to the judgment of all. Hence, he insists, the idea of an academy as the highest and ultimate freehold of knowledge, and as a corporation which is more independent than any other of the state, must be maintained.

In Humboldt's view, a close interchange of activities between academy and university should be provided for. Each academican must have the right to lecture at the university without going through the ordinary preliminaries, and without involving any direct connection with it. Many scholars should be both university professors and academicians, but both institutions should have other members who belong to it alone. The academy must be free to choose its own members, subject only to the approval of the government, while professors in the university should be appointed exclusively by the state.[32]

In spite of the transfer of some of its principal departments to the University of Berlin, the Berlin Academy has by no means relinquished its important object of carrying on large research projects. As already stated, it still has an endowed professorship of chemistry, recently held by van't Hoff, and now by Fischer, and a professorship of astronomy, held by Auwers. Both of these investigators pursue their researches under the auspices of the Academy. The great work upon which Professor Auwers is engaged is characteristic of many of the larger undertakings of the German academies, to which they devote nearly half of their available funds. This is the "Geschichte des Fixsternhimmels," an immense catalogue of star positions based upon the observations of many astronomers. Similar undertakings by the Berlin Academy in other fields are the "Corpus inscriptorum græcarum" and the "Corpus inscriptorum latinarum." The preparation of a great edition of Aristotle's works, begun by the Berlin Academy in 1821 and finished in 1909, is cited by Diels as a most striking illustration of the advantage of academic continuity, with which no individual can hope to compete.[33] For such an undertaking, which we have come to regard as characteristically German, an organized body like an academy of sciences possesses, not merely the advantage of continuity, but that which results from the combined experience and the wide range of vision brought to bear through the cooperation of many eminent authorities. An academy may also command far more extensive material than would fall within the reach of the individual worker. This phase of academic activity, practised in different forms in the Museum of Alexandria and, in the preparation of national dictionaries, by the Académie Française and the Accademia della Crusca, is also illustrated in England by the Royal Society's "Catalogue of Scientific Papers." Our own National Academy has yet to take any steps in this direction.

The importance attached to this form of academic work in Berlin is clearly illustrated in the plans of the new academy building, for a set of which I am indebted to the kindness of Professor Diels. This building, which is being constructed in connection with the new Royal Library, is probably more perfectly adapted for academic purposes than any other building now in use, as it was especially designed

[32] Lenz, "Geschichte der Universität Berlin," Bd. I., pp. 186–188.

[33] Diels, "Die organisation der Wissenschaft," in "Die Allegemeinen Grundlagen der Kultur der Gegenwart," 2d ed., p. 667.

for the work to be carried on in it.[34] The plans show that one room each is to be devoted to the *Corpus medicorum Græcorum,* the *Acta Borussia,* and the Plant Kingdom, three rooms to the *Corpus inscriptorum Latinarum,* four to the Oriental Commission, four to the Egyptian Dictionary, eleven to the *Inscriptiones Græcæ,* eleven to the German Commission, two to the edition of Leibnitz's collected works, seven to the History of the Fixed Stars. In addition to all of these rooms for special research, there are the great "Fest Saal," separate meeting rooms for the two classes of the Academy, a general meeting room for both classes together, a large anteroom, a demonstration room, seven editorial rooms, four secretaries' offices, offices for the registrar, the recorder and the chancellor, a reading-room and large library and stack room, a correspondence room, an instrument room, a photographic laboratory, and various other offices, kitchens, servants' rooms, etc.

It is a significant fact that Merz, after devoting an eloquent chapter to the evolution of science in France under the stimulus of the Paris Academy, barely mentions the German academies when discussing the progress of science in that country. The reason, as we have already seen, lies in the predominating influence of the universities in the development of German scientific life and thought. With every teacher an investigator, every university a laboratory of research, and with the powerful aid of the state encouraging in every possible way the prosecution of investigation no less than the instruction of students, it is easy to see how the universities obtained their ascendancy in the field of science, or rather in the broad field of *Wissenschaft,* for in Germany the same spirit of research has permeated every department of knowledge. The wide distribution of the universities and their considerable number, together with the free interchange of professors and students, have worked against centralization, and have served to create a cosmopolitan spirit in striking contrast with that which obtains in France. One can hardly fail to believe that no single influence could be more effective than the universities for the development of the latent capacity of a nation for scientific research. But while the German academies have doubtless suffered by contrast with the universities, a survey of the intellectual progress of Germany should by no means overlook the invaluable services they have rendered.

It would seem, however, that these services might have been even greater if a larger number of the scientific men of the nation could have taken an active part in the work of the academies. As at present constituted, the membership of these bodies is extremely limited, and the requirement that each member must reside within a very short distance of the seat of the academy, so that he may be able to attend the meetings regularly, is in striking contrast with the wider membership and freer interchange which seem to have been essential elements in the extraordinary development of the university system.

When we pass to England, and examine into the conditions of intellectual progress, we find a fundamentally different condition of affairs. This reflects the natural characteristics of the English people, just as the university system of Germany and the academic activities of France illustrate the essential qualities of these nations. Merz's picture of the growth of scientific research in England is in some respects a somber one. In his view the Royal Society appears to have played no part in advancing the

[34] Most of the European academies are housed in palaces or similar buildings formerly used for other purposes.

intellectual life of the nation and the Royal Institution, as well as Oxford and Cambridge, fare little better at his hands.

Now no one will attempt to deny that the characteristic quality of British science has always rested in the individual, and that organized efforts there have played a less conspicuous part than in France or in Germany. During a large part of their history, Oxford and Cambridge have done little for research, though the past half century has seen an extraordinary change in this respect, particularly in the case of the Cavendish laboratory, whose succession of brilliant leaders can hardly be matched in the history of any other university laboratory. Men whose names are famous in science have sprung up in the most unexpected places, without ancestry, training or encouragement to account for the dominant influence they have exerted on the scientific thought of the world. A notable illustration of this kind is afforded by Faraday, whose obscure origin, extreme poverty, and lack of the assistance of schools, were most fortunately offset by his transcendent genius and by the influence of Davy, whose lectures at the Royal Institution soon transformed the bookbinder's apprentice into Davy's brilliant successor. Darwin, though of distinguished ancestry, was another English "amateur" whose work was done apart from the universities. A host of others might be mentioned, whose extraordinarily original contributions to scientific thought have found few equals in other lands. For the most part, they have worked alone and sometimes unaided, and their great results have been achieved in spite of conditions which may appear unfavorable and discouraging. But in my opinion the Royal Society and the Royal Institution, not to speak of other important agencies, such as the societies devoted to special branches of science, have exercised in England a profoundly favorable influence which can not be ignored.

In failing to take note of this in his classic work, Merz seems to exhibit some traces of that pessimistic quality which is not infrequently encountered in English life. It is to short-sightedness of the government and to individual conservatism, tinctured with pessimism, that I should be inclined to charge that lack of support of scientific men of which Merz so feelingly complains, rather than to the Royal Society and other organized bodies for the promotion of science. As a matter of fact, it is easy to show that these institutions have exerted a powerful stimulus, without which the progress of science in England undoubtedly would have been delayed.

In the first place, the Royal Society has extended the distinction and privileges of its fellowship to a much larger number of investigators than have been similarly honored by the continental academies.[35] Every investigator in science will understand and appreciate the benefit which such recognition entails. Most of all the obscure individual worker, unnoticed and unsupported by the universities, but wholly devoted to the pursuit of science, must benefit by such moral support. On the continent I have known investigators of this type, not connected with a university, and receiving no aid or encouragement from neighboring university men, who could not be recognized by election to the academies because of their limited membership or their fixed traditions. In England such men would have been received into the Royal Society, which would have been glad to publish their papers as Fellows and to aid them in other ways.

A notable illustration is afforded by the case of Newton, elected a fellow of the

[35] Fifteen new members are elected annually, making a total membership of 477 (Jan. 1, 1913).

Royal Society on January 11, 1671, and subsequently its president for the long period of twenty-four years. A month following his election, Newton communicated to the Society his discovery of the composite nature of white light, which, when published in the *Philosophical Transactions*, was the first of his productions to appear in print. In expressing his thanks to the Society, Newton remarked:[36]

> It was an esteem of the Royal Society for most candid and able judges in philosophical matters, that encouraged me to present them with that discourse of light and colors, which since they have so favorably accepted of, I do earnestly desire you to return them my most cordial thanks. I before thought it a great favor to be made a member of that honorable body, but I am now more sensible of the advantage: for believe me, Sir, I not only esteem it a duty to concur with them in the promotion of real knowledge, but a great privilege, that, instead of exposing discourses to a prejudiced and censorious multitude (by which means many truths have been baffled and lost), I may, with freedom, apply myself to so judicious and impartial an assembly.

Leuwenhoeck, "the father of microscopical discoveries," who communicated no less than 375 papers and letters to the Society during a period of fifty years, bequeathed a collection of microscopes "as a mark of my gratitude, and acknowledgment of the great honor which I have received from the Royal Society."[37]

When the Royal Observatory was established at Greenwich, the government failed for a period of nearly fifteen years to furnish it with a single instrument. In this extremity Flamsteed appealed to the Royal Society, with the following result recorded in the minutes:

> It was ordered that the astronomical instruments belonging to the Society be lent to the Observatory at Greenwich, and that Mr. Hooke's new quadrant be forthwith finished at the charges of the Society.[38]

Examples of this nature might be multiplied indefinitely, but a single case will suffice, since no more striking instance of the splendid results directly due to the encouragement and aid of the Royal Society could be asked than that illustrated in the life and work of Sir William Huggins, one of the founders of astrophysics, and a typical example of the English "amateur" investigator.[39] Sir William, to whose addresses as president of the Royal Society we shall have occasion to refer later, was not a university man. With his accomplished wife as his only assistant, he lived and did all his work at Upper Tulse Hill, well removed from the bustle of Piccadilly on the Surrey side of the Thames. It is more than probable that without the stimulus and aid of the Royal Society much of his great work could not have been done. For it was on returning home from a Royal Society meeting in company with his friend Miller that he first conceived the idea of observing the spectra of stars, and it was with telescopes and other instruments loaned to him by the Society that his classic observations were made. In spite of fogs and clouds of London smoke, he continued his work up to the very end of his long life, dividing his allegiance to science only between his astrophysical investigations and the development of the Royal Society, of which he was for forty years a leading Fellow.

Thus, in spite of that early poverty which prevented the Royal Society from publish-

[36] Weld, "History of the Royal Society," Vol. I., p. 237. Brewster's "Life of Newton" gives an interesting account of Newton's relations with the Royal Society and his plan for its improvement (Vol. I., p. 102).

[37] Weld, *ibid.*, p. 245.

[38] Weld, *ibid.*, p. 255.

[39] It is hardly necessary to say that the term "amateur" is used here to denote one who works in science for the pure love of the subject, and not in the sense of dilettante.

ing the "Principia" of Newton, it has lent its powerful aid and support to many a British investigator, who without it would have been absolutely isolated. Its large collection of instruments, the accumulation of more than two centuries, is freely placed at the disposal of those who need them. Its *Philosophical Transactions* and *Proceedings* have furnished the most desirable means of publication for an enormous mass of scientific literature. Its meetings bring together every Thursday at Burlington House the leading scientific men of the kingdom, and furnish an opportunity for stimulating interchanges of view which have played a great part in scientific progress. Its various gold medals, impartially bestowed at home and abroad, in recognition of advances in science, have been powerfully supplemented by financial assistance to investigators from the Government Grant Fund of £4,000 per annum, which is administered by the Society. To its influence is largely due the high standard of efficiency maintained by the government in its appointment of astronomers royal and other directors of the scientific research of the nation. When the government decided to establish a national physical laboratory it turned at once to the Royal Society, to which it delegated the planning and control of this great institution. Its *Catalogue of Scientific Papers,* continued as the *International Catalogue of Scientific Literature,* has contributed in a most important way to the accessibility and usefulness of the literature of science, and is indispensable to every investigator. It has supplied both money and instruments to scientific expeditions sent to all parts of the globe, and provided for the suitable reduction and discussion of the observations obtained. It has aided the government of India in the work of the Indian Meteorological Department and participated with the meteorological office in the direction of the work of the Kew and its sister observatories. The reports of the Sleeping Sickness Commission have advanced in an important degree our knowledge of tropical diseases. In fact, one could point to an almost unlimited number of illustrations of the beneficent activities of the Royal Society as the leading representative of British research, and as one of the most powerful factors in broad projects of cooperation, such as those of the International Association of Academies.

Unlike the academies of St. Petersburg, Berlin, Vienna and Stockholm, which maintain large research laboratories or support research professorships, the Royal Society has no laboratories of its own. Closely allied with it, however, is the Royal Institution, formerly known as "the workshop of the Royal Society." No laboratory in existence can match its extraordinary record, accomplished at an almost incredibly small cost.[40] When one recalls Young's great work in laying the foundation of the wave-theory of light, not to speak of his success in discovering the first clue to the translation of Egyptian hieroglyphics; Davy's long series of discoveries in chemistry, and his brilliant lectures and demonstrations; Faraday's unparalleled achievements in physical and chemical research, and the dignity and luster he imparted to the popular presentation of scientific results to a general audience; Tyndall's success in the same lecture-hall, and his services in popularizing science in the United States; and the long series of important investigations, especially in the fruitful field of low temperature phenomena, which we owe to Dewar, who has now occupied the chair of chemistry even

[40] Dewar, address as president of the British Association, Belfast, 1902, p. 11.

longer than Faraday: these form a record remarkable in the annals of science, with returns so rich as to be worthy of the expenditure of almost any sum. But even this long list does not represent the total product of the laboratory, where such eminent leaders as Lord Rayleigh and Sir Joseph Thomson have also conducted investigations of the first importance. So far as my own observations have gone, no other laboratory holds such an atmosphere of research or stimulates so powerfully the imagination of the investigator. I shall have occasion later to refer to the equally remarkable success of the Royal Institution in diffusing and popularizing knowledge through its course of experimental lectures.

Academies of the first class are so numerous that only a few of the oldest organizations, whose work bears directly upon the problems of our own National Academy, can be mentioned in this paper. I hope to have opportunity at some future time to describe the work of such influential bodies as the Vienna Academy, which has founded a Radium Institute and taken steps which should result in the establishment of a Solar Observatory; the Stockholm Academy, entrusted with the responsibility of awarding the Nobel Prizes in physics and chemistry; the Amsterdam Academy, focus of the great research work of Holland; and many other academies of the highest rank representing the various nations of Europe. For the present I must limit attention to a group of institutions which are sufficient to typify the wide range of academic activities. However, a word must be added regarding the St. Petersburg Academy, established by Catherine I. on the plans of Peter the Great in 1725, because of its special plan of organization. The president, director and fifteen members are paid annual stipends ranging from one thousand to three thousand dollars, and provided with dwelling houses. The great academy building, with its library of over 36,000 books and manuscripts, contains large laboratories in which investigations are constantly in progress. The extensive publications include researches in every field of knowledge and exhaustive memoirs on the topography, geography and history of Russia and the manners, customs and languages of its various peoples.

From this survey of the work of a few of the leading academies and allied institutions, we see that original investigations have played a large part in their activities, from the days of the great museum at Alexandria to the present time. In certain instances, illustrated in the history of the University of Berlin, some of the work of investigation has been transferred from the academies to the universities, but without interrupting the larger activities of the academies in the same field. Again, in cases like that of the Royal Society, the development of a closely allied laboratory of research, such as that of the Royal Institution has partially supplied the place which a laboratory under the exclusive control of the Society might have held. The essential thing to note is the advantage which results from the organic relationship of an academy with a laboratory for the production of new knowledge. An academy will reach its greatest influence, and serve its most useful purpose in stimulating the work of its members, when it is recognized as an institution primarily "for the increase" rather than "for the diffusion of knowledge among men."

In the field of publication, the great academies of former times were predominant factors, so much so that we owe to their printed pages the great volume of the original contributions of the earlier days of science. With the rapid extension of

the facilities for research, and the extensive ramifications of science into special fields, the societies and journals devoted to particular lines of research naturally arose and multiplied. The prestige of such publications as the *Proceedings* and *Transactions* of the Royal Society fortunately enables them to hold their own, in spite of the competition of so many journals devoted to special subjects. And the opportunity afforded by academies for the publication of extended memoirs beyond the range of ordinary periodicals, is universally appreciated. As regards shorter communications, the peculiar claims of the special journals, which have been proved by time to serve the purposes for which they were designed, would naturally receive consideration in elaborating any new plan of academic publication to meet existing needs. This subject will be more fully considered in a later paper.

In the management and distribution of trust funds for research, the loan of instruments, the award of prizes, and especially in the advice of governments and individuals as to the best means of initiating and conducting scientific enterprises, national academies occupy a position which private foundations can hardly hope to rival. The value of advice received from a body of the highest reputation and prestige is greatly enhanced, because of the increased probability that it will be heeded and carried into effect. For a similar reason, recognition of individual achievement through the award of prizes or election to membership acquires its greatest weight when received from such a body.

After reviewing all of the activities which we see so diversely exemplified by the national academies of different countries, the conviction is forced upon one that the first and best object of these bodies must always be to uphold the dignity and importance of scientific research, and to diffuse throughout the nation a true appreciation of the intellectual and practical benefits which will inevitably result from its support and encouragement. But to accomplish great results in this field, an academy must enjoy the active cooperation of the leaders of the state. To appreciate this, we have only to remember the many striking illustrations afforded in the history of civilization. What was done by Alexander the Great and the Ptolemies for Egypt, by the house of Medici for Italy, by Richelieu, Colbert and Napoleon for France, can be done for other nations by living statesmen to-day. In the midst of his campaigns Napoleon never forgot the paramount claims of science and the arts. Writing to the astronomer Oriani from Milan, which he had entered in triumph, Napoleon said:

> The sciences which do honor to the human mind and the arts which embellish life and perpetuate great achievements for posterity, should be especially honored under free governments.
>
> . . . I invite the scholars to meet and to give me their opinions as to the means that should be taken, and the needs to be fulfilled, in order to bring new life and activity into the sciences and the fine arts. Those who wish to go to France will be received with distinction by the government. The French people set a higher value on the acquisition of a skilled mathematician, a celebrated painter or a distinguished man of any profession, than upon the possession of the largest and richest city.[41]

That such views are still shared by modern rulers is illustrated by the recent establishment of a great institution for scientific research by the Emperor of Germany.

This article can not be better closed than by a quotation from Laplace, the most distinguished member of the Paris

[41] Maindron, "L'Académie des Sciences," p. 205.

Academy in its brilliant days under the first empire.

Nature is so varied in her manifestations and phenomena, and the difficulty of elucidating their causes is so great, that many must unite their knowledge and efforts in order to comprehend her and force her to reveal her laws. This union becomes indispensable when the progress of the sciences, multiplying their points of contact, and no longer permitting a single individual to understand them all, throws upon a group of investigators the task of furnishing the mutual aid which they demand. Thus the physicist appeals to the mathematician in his efforts to arrive at the general causes of observed phenomena, and the mathematician in his turn consults the physicist, in order to render his investigations useful by practical applications, and in the hope of opening up new possibilities in mathematics. But the chief advantage of academies is the philosophic spirit which must develop within them, thence diffusing itself throughout the nation and permeating every interest. The isolated scholar may yield with impunity to the tendencies of the systematist, since he hears only from afar the criticism that he arouses. But in an academy the impact of such tendencies ends in their destruction, and the desire for mutual conviction necessarily establishes the rule of admitting only the results of observation and calculation. Furthermore, experience has shown that since the origin of academies the true spirit of philosophy has prevailed. By setting the example of submitting everything to the test of severe logic, they have overthrown the preconceived notions which too long dominated science, and were shared by the ablest minds of previous centuries. Their useful influence on public opinion has dissipated errors greeted in our own time with an enthusiasm which would have perpetuated them in earlier days. Equally removed from the credulity which denies nothing and the conservatism which would reject everything that departs from accepted ideas, they have at all times wisely awaited the result of observation and experiment on difficult questions and unusual phenomena, promoting them by prizes and by their own researches. Measuring their approval no less by the greatness and difficulty of a discovery than by its immediate utility, and convinced, by many examples, that what appears to be least fruitful may ultimately yield important consequences, they have encouraged the pursuit of truth in all fields, excluding only those which the limitations of the human understanding render forever inaccessible. Finally, we owe to them those great theories, elevated by their generality above the comprehension of the layman, which through numerous applications to natural phenomena and the arts, have become inexhaustible sources of happiness and enlightenment. Wise governments, convinced of the usefulness of scientific societies, and regarding them as one of the principal causes of the glory and prosperity of empires, have established such bodies in their very midst, in order to profit by their counsel, which has often brought lasting benefits.[42]

George Ellery Hale

THE BALTIMORE MEETING OF THE NATIONAL ACADEMY OF SCIENCES

The National Academy of Sciences will meet November 18 and 19 at the Johns Hopkins University, Baltimore. The council will meet the evening before; and on these two dates there will be public sessions with papers by members of the academy and others.

A preliminary program of these papers is as follows:

Henry Fairfield Osborn: *Final Results on the Phylogeny or Lines of Descent in the Titanotheres.*

Thomas H. Morgan: *The Constitution of the Chromosomes as Indicated by the Heredity of Linked Characters.*

The paper is a discussion of recent discoveries in sex-linked inheritance and their bearing on the mechanism of heredity and the constitution of the chromosomes. Starting with the assumption that Mendel's law of segregation finds a plausible explanation in the processes known to occur in the ripening of the egg and sperm, an attempt is made to analyze the ratios that appear in sex-linked inheritance—ratios that depart from those that rest on the assumption of independent assortment of pairs of characters. It is shown how these departures find a reasonable explanation on the assumption that interchange takes place between members of the same pair of chromosomes. The Mendelian ratios, on the

[42] "Exposition du Système du Monde," *Oeuvres*, Vol. VI., p. 418.

other hand, occur when the pairs of factors involved lie in different chromosomes. The method by which the location of loci (factors) in the chromosomes is calculated will be explained.

H. McL. EVANS: *The Action of Vital Stains Belonging to the Benzidine Group.*

S. O. MAST: *Changes in Pattern and Color in Fishes, with Special Reference to Flounders.*

The flounders ordinarily lie on the bottom and the skin assumes a color and pattern so nearly like that of their environment that it is frequently difficult to see them. On a black bottom they become black, on a white bottom white, on a yellow bottom yellow, on a blue bottom bluish, on a red bottom reddish, etc. All of these changes in the skin are regulated through the eyes. This indicates color vision. If the bottom is finely mottled the pattern in the skin assumes a fine grain; if coarsely mottled, it assumes a coarse grain. But there is no evidence indicating an actual reproduction of the configuration of the background. If, after the skin has become adapted to a given bottom, the fish are moved to a different bottom they tend to return to the original. That is, they tend to select a bottom which harmonizes with their skin.

D. S. JOHNSON: *The Perennating Fruits of the Prickly Pears.*

The fleshy fruits of certain prickly pears are not shed, as most fruits are, but remain attached for ten years or more. These fruits continue to grow by a cambium and, while they remain attached, their axillary buds give rise to flowers only. If, however, the chains of fruits thus formed are separated from the plant their buds give rise only to roots and vegetative joints. The plants are propagated in this way. Seeds, though sometimes formed, have never been seen to germinate.

B. F. LOVELACE: *A Static Method for the Measurement of Vapor-pressures of Solutions.*

The method is based upon the principle of the Rayleigh manometer. Vapor from solvent, carefully freed from air, is admitted to one limb of the manometer and vapor from solution to the other limb. The manometer is constructed to give a sensibility of 0.0005 millimeter and readings are made in the usual way by means of a telescope and scale. Provision is made for stirring the solution, also for removing air to less than 0.0004 millimeter pressure, the pressure in system due to air being measurable at any time during the progress of an experiment.

H. C. JONES: *The Absorption of Light by Water Containing Strongly Hydrated Salts.*

Salts, such as magnesium and calcium chlorides, which, in aqueous solution combine with a large amount of the solvent, diminish the power of water to absorb light. Unhydrated salts, such as potassium and ammonium chlorides, produce no such effect. This would indicate that water combined with a dissolved substance has less power to absorb light than free water. This fact is in keeping with a number of others which have recently been brought to light; and they all seem to point to the general correctness of the solvate theory of solution.

SIMON FLEXNER: *Some Factors in the Epidemiology of Infection.*

KNIGHT DUNLAP: *The Fusion of Successive Flashes of Light.*

The least perceptible interval between two light stimuli is dependent on several factors, among which is the relative duration of the stimuli and the dark interval. As determined in extensive preliminary experiments with a beam of light interrupted at its focus by a properly sectored rotating disc, the least perceptible interval ranges from approximately 20 σ when the two stimuli are equal in length to the dark interval, down to 4 σ when the stimuli are 18 times the length of the intervening interval. This variation is principally a function of the length of the first stimulus, the length of the second stimulus having a slight effect of different character. Corresponding measurements for flicker give somewhat lower results, namely, from approximately 11 σ to 2 σ. The difference in these measurements is readily explained.

J. J. ABEL: *Demonstration of an Artificial Kidney.*

HOWARD A. KELLY: *Radio-therapeutics in Surgical Affections.*

A. H. Pfund: *Measurement of Stellar Radiation.*

Using a compensating vacuum-thermocouple with evacuator—both of new design—in conjunction with the 30-inch Keeler Memorial Reflector at the Allegheny Observatory, the radiation from Vega, Jupiter and Altair was observed. The sensibility of the apparatus corresponded to a deflection of 2,400 mm. for a meter—Hefner. The results for the evening of September 22, 1913, were:

Source	Deflection, Mm.	Magnitude	Remarks
Vega.....	7.5	0.19	Sky clear; no wind
Jupiter.....	3.0	—2.0	Sky clear; no wind
Altair.....	2.0	0.96	Sky hazy; no wind

(The smallness of the deflection occasioned by Jupiter is due to the circumstance that the image had more than seven times the area of the blackened disc of the thermo-junction.)

J. A. Anderson: *A Method for Testing Screws.*

The instrument used is the Fabry and Perot interferometer, and the method is applicable to any screw which has been ground. Periodic errors, errors of run, straightness of the axis, and coincidence of the axis of the screw with that of its pivots can all be determined with a high degree of accuracy. The method has been used in testing the screws for Rowland's ruling machines with success.

J. B. Watson: *An Experimental Study of Homing.*

This report will discuss briefly four of the more important theories of homing, viz., the "law of counter return"; the theory of return by the aid of "visual land-marks"; the theory of "direct perception of goal" (by the aid of infra-red rays); and the "Spürsinn" of Cyon. The result of three years of experimental work in the Dry Tortugas on homing in the noddy and sooty terns will be given; special emphasis was placed upon the results obtained during the past spring. In brief, the experimenters were able to obtain thirteen returns over open water from distances ranging from five hundred to approximately one thousand miles.

On the afternoons of both the days of the meeting opportunity will be given for visits to several of the laboratories of the Johns Hopkins University, besides the Physical Laboratory in which the meetings will be held.

In the laboratories of anatomy, plant physiology, zoology and chemistry special demonstrations will be given of the researches in progress.

There will be the usual social functions, including a reception by Dr. and Mrs. Remsen and a dinner at the Maryland Club to which the Academy is invited by the members resident in Baltimore.

SCIENTIFIC NOTES AND NEWS

Alfred Russel Wallace, the great English man of science, author of works on natural selection, geographical distribution and a wide range of biological and social subjects, died on November 7, in his ninety-first year.

Sir William Preece, the distinguished British electrical engineer, died on November 6, at the age of seventy-nine years.

Dr. Charles McBurney, formerly demonstrator of anatomy and professor of surgery in the College of Physicians of Columbia University, died on November 6, aged sixty-eight years.

A marble bust of Lord Kelvin by Mr. Shannon, A.R.S.A., the gift of Lady Kelvin, was presented to the Royal Society of Edinburgh on October 28, by Professor Crum Brown, on her behalf. Principal Sir William Turner, who presided over a large gathering, said Lord Kelvin had been sixty years a fellow of the society, and was occupying the post of president for a third term of five years when he died in 1907.

At the annual meeting of the American Mathematical Society, to be held at Columbia University on December 30–31, Dean H. B. Fine, of Princeton University, will deliver his presidential address on "An Unpublished Theorem of Kronecker Respecting Numerical Equations."

At the dedicatory exercises of the new $100,000 laboratory building of the college of medicine of the University of Nebraska, held in

Omaha on October 16, the two principal speakers were Dr. Howard A. Kelly, of the Johns Hopkins University, and Dr. Henry B. Ward, of the University of Illinois.

SIR RICKMAN JOHN GODLEE, president of the Royal College of Surgeons, England, had the honorary degree of doctor of laws conferred on him at a special convocation of the University of Toronto, November 5. At the Academy of Medicine on the evening of the 4th, Sir Rickman delivered an address on foreign bodies in the air passages.

DR. LUDWIG RADLKOFER, professor of botany at Munich, has been permitted to retire from the active duties of his chair.

THE special board for biology and geology of Cambridge University has approved a grant of £30 from the Balfour Fund to Mr. George Matthai, B.A., research student of Emmanuel College, in aid of his research on the comparative morphology of the madreporaria.

THE address by Professor G. A. Miller entitled "Some Thoughts on Modern Mathematical Research," which appeared in SCIENCE, June 7, 1912, has been reprinted in the October, 1913, number of *The Journal of the Indian Mathematical Society*, Madras, India. It has also been reprinted in the "Annual Report of the Smithsonian Institution of Washington" for 1912.

UNIVERSITY AND EDUCATIONAL NEWS

COMPLETE plans for the new home of the Massachusetts Institute of Technology have been made public. There are to be nine contiguous buildings, each devoted to a separate department. Construction has already been started on the Cambridge side of the Charles River, east of Harvard Bridge. The principal buildings are expected to be ready for occupancy in two years. Of the $10,000,000 necessary, $7,300,000 has already been pledged.

THE Chamber of Commerce of New York City announces a gift from a donor whose name is withheld of $500,000 for a building for a college of commerce. Gifts have also been received of $50,000 from four other subscribers. The Chamber of Commerce proposes to provide a building and to install a commercial and civic museum on condition that the City of New York provides the running expenses.

THE University of California announces that the income of the $120,000 given by Mrs. Jane K. Sather to endow the Sather professorship in classical literature is to be used for a visiting Sather professor. Annually some distinguished scholar, from Europe or from America, will be called to Berkeley to spend a half year or a year teaching in the University of California. The first incumbent is to be Professor John L. Myres, of Oxford University, who will come from his present work of excavation in the island of Cyprus. Besides liberally endowing the Sather professorship in classical literature, Mrs. Jane K. Sather, of Oakland, gave a like amount to endow the Sather professorship of history, now held by Professor H. Morse Stephens; endowed the three Sather book funds, to purchase works in classics, history and law; built the Sather Gate, in memory of her husband, at a cost of $37,000, and gave $200,000 for the three-hundred-foot white granite Sather campanile, now being built on the campus, and $25,000 for the Sather bells, a set of chimes which are to be placed in the open belvedere of the campanile, 250 feet above the level of the campus.

THE University of Florida will use two new buildings for the first time at the coming session: the Language Hall, costing $45,000, will house departments of law, languages, English history, mathematics and administrative offices; the George Peabody Hall, for the teachers college and normal school, costing $40,000, the gift of the General Education Board, will house the general library, departments of education and philosophy, normal school and practise high schools.

THE president of the Ohio State University and a group of members of the legislature have visited the universities of Wisconsin, Michigan and Illinois to obtain information for the development of the Ohio State University.

DR. HOLLIS GODFREY, an engineer of Philadelphia, the author of contributions to chem-

istry and sanitary engineering, has been elected president of the Drexel Institute of Art, Science and Industry.

John Ellsworth Hartzler, the newly elected president of Goshen College, was inaugurated on November 7. President Winthrop E. Stone, of Purdue University, and President Robert L. Kelly, of Earlham College, represented the universities and colleges on the program on this occasion.

The following appointments have been made in the school of civil engineering, Purdue University: H. B. Smith, instructor in railway engineering; A. L. Dierstein, instructor in structural engineering; W. E. Stanley, assistant in surveying.

Recent appointments in science in West Virginia University are as follows: Wm. Henry Schultz, Ph.D., professor of pharmacology and materia medica; Aaron Arkin, M.D., Ph.D., professor of bacteriology and pathology; A. H. Foreman, E.E., M.E., Ph.D., assistant professor of electrical and experimental engineering; L. I. Knight, Ph.D., plant physiologist in the experiment station, in cooperation with the University of Chicago; E. L. Andrews, assistant professor of poultry husbandry; Isaac B. Johnson, B.S.Agr., instructor in animal husbandry; Oliver Smith, B.S.Agr., instructor in agronomy; W. B. Kemp, B.S.Agr., instructor in agronomy; O. M. Kile, B.S.Agr., agricultural editor; John Heron Illick, M.S., instructor in zoology; Joseph W. Hake, M.S., instructor in physics; Hubert Hill, B.S., instructor in chemistry; W. A. Price, Ph.D., instructor in geology; Edward F. Woodcock, M.A., instructor in botany.

Recent appointments at the University of Florida include: L. W. Buchholz, A.M., and W. S. Cawthon, A.M., as professors of education in the newly organized teacher's college; R. R. Sellars, B.S. (Bucknell), instructor in civil engineering; A. J. Strong, B.S. (Mich. Agr.), instructor in mechanic arts, both in college of engineering; Ira D. Odle, B.S. (Purdue), instructor in botany and bacteriology; J. F. Duggar, Jr., M.S. (Ala. Poly.), instructor in agronomy, in the College of Agriculture. In the Agricultural Experiment Station, laboratory assistants have been appointed as follows: A. C. Mason, B.S. (Mich. Agr.), in entomology, J. Matz, B.S. (Amherst), in plant pathology. O. F. Burger, assistant plant pathologist, has been granted leave of absence for study at Harvard University.

The extension division of the University of Florida was made a separate and independent portion of the university organization, with P. H. Rolfs, as director, and A. P. Spencer, as vice-director. All extension service will be concentrated in this division, including farmers' institutes; farmers' demonstration and boys' and girls' club work, in cooperation with the Bureau of Plant Industry of the United States Department of Agriculture; literary and scientific lecture bureau; instruction for teachers and county institutes; correspondence courses, etc.

Mr. A. G. Steele has been appointed head of the department of psychology in Temple University, Philadelphia, Pa.

Professor Franz Cosmat, of Gratz, has been called to the chair of geology at Leipzig.

Dr. Adolf Windaus, of Freibourg, has accepted the chair of chemistry at Innsbruck.

Discussion and Correspondence

Absorption of the Sun's Energy by Lakes

To the Editor of Science: The Wisconsin Geological and Natural History Survey has been making a study of the rate at which the energy of the sun's rays is absorbed as they penetrate the water of lakes. Two instruments have been used for this purpose. The first is a black-bulb thermometer *in vacuo;* a so-called solar thermometer. The instrument is exposed to the action of the sun at different depths, say 1 m. and 2 m. from the surface. The rate of rise of the mercury is noted and from the relation of the rates at the two depths can be computed the amount of absorption of heat in the stratum between them. The second instrument is a thermopile and galvanometer, designed for the purpose by Professor C. E. Mendenhall, of the department of physics, University of Wisconsin, and constructed in

the university shops. The method of observation is much the same as with the solar thermometer, but the instrument is much more sensitive and rapid in its action. Readings are made in a few seconds and the instrument will easily record an amount of heat as small as 1 per cent. of that present at the surface. The results obtained by the two instruments are in substantial agreement. Observations have been made on a stratum of water of considerable thickness (1 m. or 0.5 m.) and have usually dealt with strata beginning at 0.5 m. or 1 m. below the surface—a depth at which all, or nearly all, of the invisible part of the spectrum has been absorbed.

It has long been known that a stratum of optically pure water 1 m. thick absorbs about 60 per cent. of the sun's energy, including nearly all of that below the *A* line. In pure water the absorption below one meter would amount to less than 12 per cent. of the energy present at a given depth in the 1 m. stratum immediately subjacent. These figures are subject to variation, depending on the altitude of the sun and the form of the energy spectrum.

Lake water is optically very different from pure water. The inland lakes of Wisconsin are not very transparent; the transparency, as shown by Secchi's disk, varying from less than 1 m. to about 7 m. The transparency is affected both by turbidity, due to suspended matter, and to stain, occasioned by matters extracted from peat, etc.

Observations made on more than twenty-five lakes showed that not more than 20 per cent. of the sun's energy present at the surface is found at a depth of 1 m., and the amount is usually much less; sometimes as low as 2 per cent. or 2.5 per cent. Not less than 30 per cent. of the energy present at 1 m. is absorbed by the stratum of water between 1 m. and 2 m.; usually as much as 40 per cent. to 50 per cent. is absorbed; and the amount may be as great as 85 per cent. to 95 per cent. The rate of absorption per meter is substantially the same in subjacent meters as it is between 1 m. and 2 m. No readings have been made at a greater depth than 6 m., since at greater depths the energy was always too small for accurate measurement.

From these observations it follows that the heat of the sun's rays is practically absorbed entirely by the upper meters of the lake. So much as 1 per cent. of the energy present at the surface is rarely found at a depth so great as 5 m., and usually the 1 per cent. point is reached between 3 m. and 4 m., or even higher. It is quite impossible that an appreciable diurnal rise in temperature should be found in these lakes at the depth of 5 m., and practically the entire seasonal rise of temperature at 5 m. and below is due to mechanical agencies—chiefly, if not wholly, wind—rather than to insolation. It follows also that there is in general no relation between the depth to which the heating of the sun's rays penetrates and the thickness of the epilimnion.

An interesting and (to me) unexpected result of these observations is the not uncommon absence of correlation between the transparency of the water, as shown by Secchi's disk, and the rate of absorption of energy. Stained water may be much more transparent, as measured by the disk, than turbid water which is not stained, but in such cases the rate of absorption of energy may be relatively, or absolutely, greater in the stained water. For instance, Marl lake, whose water is clear but turbid with marl, had on August 21, 1912, a transparency of 1.8 m. and a rate of absorption of the sun's energy below 1 m. of about 55 per cent. per m. On August 17, 1912, Otter lake, a near neighbor, whose water is stained but not turbid, had a transparency of 5.2 m. and an absorption of about 54 per cent. Numerous observations have been made, which give similar results. It may be noted also that bottom growing plants were found abundant to substantially the same depth in these two types of lakes.

This work is still in progress and when completed will be incorporated in a general report on the temperatures of Wisconsin lakes.

I may add that for three years past the heat delivered by sun and sky at Madison has been recorded at the United States Weather

Bureau by a Callendar sunshine receiver and recorder. The temperature of Lake Mendota, on whose shore is situated the station of the Weather Bureau, is ascertained by daily series of observations, taken in the deepest part of the lake. In this way are determined not only the amount and rate of the gain and loss of heat by the lake, but also the relation between the heat absorbed by the lake and that furnished to its surface by the sun.

E. A. Birge

Madison, N. J.,
October 3.

QUOTATIONS

SPECIAL TRAINING FOR HEALTH OFFICERS

A long step forward in the special training of health officers has just been taken in the organization of the "school for health officers" of Harvard University and the Massachusetts Institute of Technology.

By cooperation, especially arranged between the two institutions, it now becomes possible for properly qualified persons on payment of an annual fee of $250 to obtain access to the remarkable resources of the Harvard Medical School and other departments of our oldest university, as well as to the chemical, biological, sanitary and engineering opportunities offered by a great modern technical school. How remarkable these opportunities offered are can only be appreciated by an examination of the announcement itself, copies of which may be obtained on application to the director, Professor M. J. Rosenau, of the Harvard Medical School.

No single curriculum is laid down which all must follow, but from the many courses offered members of the school will be expected to choose such as their preparation warrants or their needs indicate. No degree of any kind is required for admission, and no degree will be awarded for the completion of the course but, instead, a certificate to be known as the certificate of public health (C.P.H.) will be given to all who complete satisfactory courses and requirements. In order to obtain the certificate in one year it will in general be required that the candidate shall be either a graduate in medicine, or in biology and public health, or be otherwise highly qualified. Failing these special qualifications, two or more years will ordinarily be necessary in order to obtain the certificate.

No one will be admitted to the school who has not completed at least two years of ordinary college work including chemistry, physics, biology and French and German, or who is not otherwise specially qualified.

Persons already engaged in public health work will be admitted under certain conditions to special courses, and every facility will be offered for obtaining equipment in public health administration and other aspects of the health officers' profession.

It is hardly necessary to say that the organization of this high-grade school marks a distinct epoch in the American public health service. It still remains, however, for the public, which is interested in the success of schools of this sort, to make sure that a reasonable tenure of office and proper salaries shall await those who are ready to devote their lives to the new profession, and much popular education along this line needs to be done.

The actual conduct of the affairs of the school has been placed by Harvard University and the Massachusetts Institute of Technology in the hands of an administrative board, composed of Professor W. T. Sedgwick, Sc.D., of the Massachusetts Institute of Technology, chairman; Professor M. J. Rosenau, M.D., of the Harvard Medical School, director, and Professor George C. Whipple, S.B., member of the American Society of Civil Engineers, secretary.—*Journal of the American Public Health Association.*

PENSIONS AT BROWN UNIVERSITY

An announcement of the new pension rules for members of the faculty of Brown University was made yesterday at the annual meeting of the corporation. That is about the only one of the great institutions in this part of the country that is not eligible to the benefits of the Carnegie Foundation, and while that might seem to place it at a disadvantage in general competition, its alumni and friends

have shown their willingness to overcome the handicap. The spirit of this university is as liberal as in any other, but some ancient special requirements have been interpreted as placing it outside the prescribed list of beneficiaries. An attempt has been made to revise the charter so as to put it into conformity with the conditions of the foundations, and while that might have been a properly expedient step to take, there may be a feeling of larger satisfaction in attaining the same results through its own efforts. After twenty-five years of service in some cases and fifteen in others, any one connected with the active work of the university is entitled, after the age of sixty-five, to a pension of four hundred dollars, plus fifty dollars for each hundred dollars of active pay. Retirement at seventy is mandatory. This overcomes what otherwise might prove a disadvantage and puts the institution on both a strong and an independent basis.—Boston *Evening Transcript.*

SCIENTIFIC BOOKS

Allen's Commercial Organic Analysis. Fourth edition, Volume VII. Philadelphia, P. Blackiston's Son and Co. 1913. $5.00 net.

Volume VII. of this comprehensive and useful work deals with vegetable alkaloids, glucosides and other "bitter" principles, animal bases, putrefaction bases, animal acids, lactic acid and cyanogen and its derivatives. Like nearly all such extensive compilations representing the joint work of many authors there are to be noted considerable variations in the excellence and value of the different chapters. Hundreds of different compounds of animal and vegetable origin are described. Their formulæ when known are given together with their medicinal value and chemical properties including characteristic tests used for their detection and estimation.

It would be easy to pick flaws in a book of that kind, since much of the material represents compilations of variable value from other books. The individual contributors have evidently been hampered more or less by the decision of the general editors to preserve the classifications of the older editions. Thus the purines are discussed in Taylor's excellent chapter on the animal bases, but uric acid, the most important of the purines, is not included. It is discussed in the chapter on animal acids. Urinary calculi and bile pigments, but not lactic acid, are included in the latter chapter.

To the commercial chemist who has to analyze many different substances and to continually turn from subject to subject, in many instances to subjects with which he has had no experience, this volume of Allen's "Commercial Organic Analysis" will prove a valuable source of information.

OTTO FOLIN

HARVARD MEDICAL SCHOOL

House Sanitation. By MARION TALBOT. Boston, Whitcomb & Barrows. 1913.

In view of the rapidly growing conviction that home-making is a science as well as an art, and the increasing purposefulness with which women are preparing themselves for this function, there is no more important need in public health than for authoritative manuals of home sanitation. It was one of the most substantial achievements of the late Mrs. Richards that she saw the need before it was generally recognized and met it by the preparation of a series of books which will always remain as inspiring models for workers in this field. Public health science has developed with such rapidity, however, that every few years makes necessary a revision of the older viewpoints. The reviewer has of late frequently been puzzled when asked to recommend a good book on home sanitation. The Sanitary Science Club of the Association of Collegiate Alumnæ, under the guidance of Mrs. Richards herself, published a book upon this subject twenty-five years ago. It has naturally become in many respects out of date; and the new work just published by one of Mrs. Richards's most distinguished pupils has been so completely rewritten as to constitute an entirely new contribution, and one which shows that the mantle of the pioneer in scientific home-making has fallen on no unworthy shoulders.

It is, indeed, refreshing, to one familiar with

the ordinary type of pseudo-sanitation contained in current literature for the housewife, to find that Dean Talbot in her first chapter quotes as a text Dr. H. W. Hill's statement that "The old sanitation was concerned with the environment, the new is concerned with the individual, and finds the sources of infectious disease in man himself rather than in his surroundings." The following principles of "the new sanitation" immediately follow as illustrations which "show changes in sanitary theory which have been abundantly and conclusively proved."

"Night air is purer than day air, and should be admitted freely to the house.

"Gases from marshes do not cause malaria.

"The quality of the air in the breathing zone is more important than the general air of the room.

"The quantity of carbon dioxide or 'carbonic acid' is not a measure of the unhealthfulness of air.

"Ordinary variations in the normal gaseous constituents of air produce no apparent effects.

"High humidity, combined with high temperature, produces the discomfort ordinarily attributed to 'bad air,' and is unhealthful.

"Ordinary buildings and rooms ventilate themselves to a considerable extent. A small house needs comparatively less provision for change of air than a large building.

"Air from properly constructed sewers is not harmful.

"Sunlight can not be depended on for disinfection or as a substitute for cleanliness. Its value is physiological, psychical, and chiefly moral.

"Actual light rather than window area should be the measure of the efficiency of room-lighting.

"Odors are not harmful physically, but when unpleasant should be eliminated by cleansing methods rather than by ventilation.

"Disinfection as ordinarily practised, especially by amateurs, is practically valueless."

These brief statements, which so well present some of the chief conclusions of recent public health science, almost constitute a syllabus of the book. They are elaborated in eight chapters, dealing with the situation of the House and Care of the Cellar, Plumbing, Air and Ventilation, Heating, Lighting and Light, Furnishing, The Country House and Household Control of Infection, and each chapter is followed by some twenty direct practical questions intended to focus the attention of the housewife on the immediate problems of her own dwelling which fall under the general subject discussed. The viewpoint is throughout thoroughly sound and up-to-date and this little book of 116 pages ought to do notable service in the cause of public health education.

C.-E. A. Winslow

COOPERATIVE INVESTIGATION OF THE MISSISSIPPIAN FORMATIONS

The Mississippian formations of the Mississippi valley states will be studied in cooperation as a result of an important field conference held during October in Missouri. The following states were represented:

Arkansas	Purdue.
Illinois	DeWolf.
Indiana	Barrett, Beede.
Iowa	Kay.
Missouri	Buehler, Hughes.
Ohio	Prosser.
Oklahoma	Ohern, Snider.
Tennessee	Purdue.
U. S. Geological Survey	W. H. Herron.

These formations measure approximately 2,000 feet, and they have been described at various times in the past without much regard for previous usage of stratigraphic units or names. Thus in a single state the same rocks are represented under three distinct names, even in comparatively recent literature.

Since considerable work on the Mississippian formations is now being done, it is important that cooperation be established between the several states concerned, and the U. S. Geological Survey. A permanent committee in charge of this matter on behalf of the states includes H. A. Buehler, of Missouri, G. F. Kay, of Iowa, and A. H. Purdue, of Tennessee. The chief geologist of the U. S. Geological Survey will cooperate with this committee in order to give future work suitable oversight, and in order to prevent friction.

The significance of this cooperative move-

ment will be apparent to all geologists and mining engineers, and it is to be hoped that similar cooperation on work relating to other state problems will be effective in the near future.

F. W. DEWOLF,
Secretary

SPECIAL ARTICLES

ON THE ACOUSTIC EFFICIENCY OF A SOUNDING BOARD

THE experiments described below appeared to yield such a variety of information, of so definite a character, that it seemed worth while to record them, in spite of their simplicity.

The chapel of Adelbert College, built in 1910, had proved unsatisfactory in its acoustic properties. The architect prescribed a sounding board, as likely to remedy the defect, and sent a sketch embodying his suggestion. It was thought worth while to make a preliminary test before erecting a permanent sounding board, and the writer was asked to take charge of the matter.

The chapel is a building of late English Gothic type. The nave is 104 feet long, with narrow and low side aisles, barely 6 feet wide, including the massive piers. The width of the nave, not including the aisles, is 30 feet. The chancel is 34 feet long and 30 feet wide, without aisles. The chancel floor is raised about 16 inches above that of the nave. Thus the general shape of the building is a long and narrow rectangle, 140 feet by 30, with no important recesses or irregularities. The ceiling is arched, about 48 feet high to the top of the arch. Its curvature is such that any focal line which might be formed by reflection would be not near the floor, but high up in the auditorium.

Experiments gave little evidence of local echo or interference. The acoustic difficulties arise chiefly from general reverberation. The problem was then to determine by direct comparison the value of a sounding board as a corrective of general reverberation.

It is evident that the experiments must be of such a kind as would appeal not merely to a physicist, but to any intelligent person. This means that they must be comparable with the ordinary use of the chapel, and must involve the hearing of ordinary speech. Yet it was of course desirable that they should have some quantitative character, and that the individual and personal characteristics of the hearers should be so far as possible eliminated or averaged.

Several members of the college faculty and two or three advanced students gave their cordial assistance. To their patience and carefulness is due whatever of value these experiments may have.

Three speakers took part, differing greatly in characteristics and in quality of voice, but all accustomed to public speaking.

It is a commonplace that ordinary speech is understood largely by context and association throughout a whole sentence rather than by actual hearing of the individual words. To eliminate this factor, lists of unconnected words were read from a spelling book, at a rate and with intonation similar to that used in a connected passage. One who has not tried this can hardly realize how much we rely on association in listening to an address. In order that this association-factor might not be left entirely out of account, a passage from some oration (always the same oration in any one set of experiments) was read in addition to the spelling-book list.

Three rows of seats on the floor, and the front row of the gallery at the back of the house, were selected as representative of the whole auditorium. The seats on the floor were the seventh, fourteenth and twenty-first from the front, and were called in the tests *G*, *N* and *U*, respectively. The position of the listener in any one row of seats, whether in the middle or on either side of the chapel made no apparent difference in the ease of hearing. The speaker was equally well heard from any part of the row, whether he stood in the pulpit, or in the middle of the front edge of the chancel floor. These facts were established by experiment before the sounding board was put in place.

The sounding board, made after the design of the architect, was of the horizontal type

now generally considered most effective. The horizontal board was hexagonal, six feet in diameter (radius of the inscribed circle), surrounded by a vertical rim which extended six inches below the plane of the board. It was supported at a height of a little more than two feet above the head of the speaker.

After a considerable number of preliminary trials, all of the same general character, a final comparative test was conducted as follows:

Eight hearers assisted, distributed through seats *G*, *N*, *U*, and the gallery. The speaker stood in his appointed place, and read a list of disconnected words from a spelling book, while each hearer noted down the number of words not understood. The speaker then read a short passage, of a known number of words, from the chosen oration, the hearers noting, as before, the words missed. The hearers then changed places, those in *G* going to *N*, those in *N* to *U*, etc., and again a list of words was read from the spelling book, and a passage from the oration. This was continued until each of the eight hearers had sat in each of the assigned seats. The number of words understood by a hearer in a given seat in any one trial was expressed as a percentage of the whole number read during that trial. The average of the percentage numbers for all the eight hearers was taken as the acoustic efficiency of the seat.

Two such sets of experiments were made, the speaker standing, in experiment I., at the front edge of the chancel floor, in the middle; in experiment II., in the pulpit, under the sounding board.

	G	*N*	*U*	Gallery
Unconnected words:				
I. On chancel floor..	96	89	80	66
II. In pulpit.....	98	91	82	62
Connected discourse:				
I. On chancel floor..	99+	98+	95	80
II. In pulpit.....	100	99	96	80

The two sets of experiments should be strictly comparable, as they were made in the same afternoon, and involved the same speakers and the same hearers in the same places. The results follow. The figures represent in each case the average percentage of words understood by the eight hearers.

These results seem to show that the beneficial effect of a sounding board in this place is very small or inappreciable. This is perhaps no more than was to be expected, for it is difficult to give any reason why a sounding board should greatly diminish the reverberation in an auditorium.

The experiments described afforded a considerable amount of other information, with regard to the most advantageous pitch of the speaker's voice, the rate of speaking, and other phases of the subject, but as such results would apply only to the auditorium studied and would have no general value, they have not been discussed.

Frank P. Whitman
Western Reserve University,
October 25, 1913

THE AMERICAN CHEMICAL SOCIETY

ROCHESTER MEETING

III

DIVISION OF PHARMACEUTICAL CHEMISTRY

B. L. Murray, *Chairman*

F. R. Elred, *Secretary*

B. L. Murray: *Chairman's Address. Legislation Affecting Pharmaceutical Chemistry.*

A. W. Bender: *The Determination of Mercuric Iodide in Tablets.*

Several methods and modifications of methods were tried on the tablets with very unsatisfactory results. The difficulty experienced was due in a large measure to the other ingredients in the tablets, namely, terra alba, potato starch, talc and gelatine. The method which was finally found to give satisfactory results is a modification of the sulphide method.

The method consists in dissolving the mercuric iodide by the use of HCl and $KClO_3$, filtering, making the filtrate alkaline with ammonia, and precipitating with H_2S.

The method was also found to be useful for the assay of mercuric iodide and oleate of mercury.

J. B. Williams: *The Insecticidal Value of Fluid Extract of Larkspur Seed.*

Fluid extracts of larkspur seed on the market at the present time show great variation in physical, chemical and insecticidal properties.

Fluid extracts obtained by extracting the seed

with various menstrua, assaying for fixed content and alkaloidal strength and testing insecticidal value on bed-bugs indicate that this preparation owes its insecticidal value more to the fixed oil content than to its alkaloidal strength.

H. V. ARNY and H. H. SCHAEFER: *The Ferric Alum Estimation of Casein.*

CHARLES BASKERVILLE: *Some Physico-chemical Considerations in Reference to Inhalation Anesthetics.*

F. O. TAYLOR: *Amyl Nitrite, Its Preparation, Purity and Tests.*

LOUIS HOGREFE: *The Chemico-legal Interpretation of United States Pharmacopœia.*

Deals with the interpretation of the National Pure-food Law, wherever it is based on the United States Pharmacopœia, especially with the interpretation of the term "drug" as defined by the law, and as understood by the U. S. P. Also the interpretation of "adulteration" as defined by the law. The paper also considers the tests laid down by U. S. P., and their interpretation according to law. Taken as a whole the paper is a brief of sec. 6 and sec. 7 of the pure-food law, as construed by the writer, alike a member of the legal profession and the profession of chemistry.

GASTON DUBOIS: *The Chemistry and Properties of Glycerophosphates.*

A. R. L. DOHME and H. ENGELHARDT: *Purity of Chemicals and Quality of Vegetable Drugs during 1912.*

H. ENGELHARDT and O. E. WINTERS: *Spirit of Nitrous Ether.*

GEO. O. BEAL and EDW. A. GLENZ: *The Composition of the Fruit of the Virginia Creeper, Ampelopsis quinquifolia.*

DIVISION OF INDUSTRIAL CHEMISTS AND CHEMICAL ENGINEERS

G. D. Rosengarten, *Chairman*

Geo. P. Adamson, *Vice-chairman Presiding*

S. H. Salisbury, Jr., *Secretary*

NORMAN A. DUBOIS: *The Protection of Iron and Steel by Paint Films.*

The theories of corrosion of iron and steel are noted and briefly considered from the standpoint of the paint technologist.

Experiments are described to illustrate the greater protecting qualities of paint films rendered less permeable to the corrosion accelerating gases of the atmosphere. Photographs are shown of exposure tests illustrating the relative increased protection of films containing diffusion retarders.

PERCY H. WALKER and S. S. VOORHEES: *Some Tests of Paints for Steel Subjected to Alternate Exposure to Air and Fresh Water.*

Fifteen paints were included in this series of tests. The tests being designed to compare pigments, the same oil and drier were used throughout. The paints were made up to a definite viscosity and applied to cleaned steel at definite spreading rates. After thorough drying the plates were placed in tanks which were filled with water each afternoon and emptied each morning. Tests were all in triplicate and all represented one, two and three coat work. Details of method of preparation of paints and plates, of painting, exposing and of inspection are given.

CHARLES H. HERTY and C. W. WILLIARD: *The Effect of Resene on Soap Solutions.*

CHARLES H. HERTY and J. O. GRAHAM: *Isoprene from Commercial Turpentine.*

HARRY MCCORMACK: *The Milling of Wheat and Testing of Flour.*

HARRY MCCORMACK: *A New Design of Coke Oven and a New Method of Coking.*

H. C. ALLEN: *The Electrolytic Reduction of Iron for Permanganate Titration.*

J. C. HOSTETTER: *A Method for the Determination of Magnesium in Calcium Salts.*

The essential part of this method is the concentrating of the Mg into a precipitate which contains but a small amount of Ca; after this, the ordinary methods of separation may be employed. This concentrating is effected by precipitating the Mg as $Mg(OH)_2$ with excess of solid $Ca(OH)_2$. The neutral chloride solution of the Ca salt (10 g. to 100 per cent.) is treated with the CaO made by igniting 0.5 gram $CaCO_3$; the solution is heated to boiling and then filtered. The precipitate is dissolved in HCl; the Ca, etc., removed by a double precipitation with NH_4OH and $(NH_4)_2C_2O_4$; and the Mg determined in the filtrate by precipitating as ammonium magnesium phosphate. Determinations of Mg in some 30 highest grade Ca salts are given.

E. S. MERRIAM: *Methods for the Examination of Natural Gas for the Production of Gasoline.*

The natural gas used for the production of gasoline is a mixture of the first 5 or 6 hydrocarbons of the paraffine series. The exact analysis of such a mixture seems possible only by fractional distillation at very low temperatures.

By determining the solubility of the gas in kerosene empirical relations between solubility and actual yield can be established.

By use of a weighed absorption vessel filled with

olive oil, the mean molecular weight of part of the condensible hydrocarbons can be calculated.

Chemical methods are not wholly satisfactory. A small laboratory compressor holding 4 liters of gas and capable of withstanding pressures up to 500 lbs. is described. By its use the yield of liquid gasoline obtainable from any gas under any working conditions of temperature and pressure can be determined quite accurately.

GEORGE A. BURRELL and FRANK M. SEIBERT: *The Condensation of Gasoline from Natural Gas.*

SIDNEY D. WELLS: *Some Experiments on the Conversion of Long-leaf Pine to Paper Pulp by the Soda and Sulphate Processes.*

One hundred and fifty small autoclave cooks were made to study the influence of various factors in the cooking operation of the sulphate process. It was found that the more caustic soda or sodium sulphide, in use, the greater the concentration, the higher the temperature and the longer the time of cooking, the lower the yields of pulp and the lighter and easier to bleach. Caustic soda had twice the reducing power possessed by sodium sulphid.

Nineteen larger semicommercial cooks were made and with a yield of pulp of 49 per cent. of the dry weight of the wood a kraft paper was made stronger and tougher than the usual imported kraft papers. Paper could be made from soda pulps of the same wood as strong but not as tough and the yields of pulp were much less.

CHAS. P. FOX: *Syrian Autoburning Limestone.*

Examination of a sample of Syrian self-burning limestone, obtained from U. S. Consul Whiting at Jerusalem, Palestine, and described by him in *Daily Consular Report* of July 21, 1911.

This rock belongs to the fossiliferous bituminous limestone formation of the Hauran district in the upper Jordan Valley.

In this section lime burning, on account of the quantity of raw material, quality of product and low cost of production, is an important industry.

Analysis of sample shows calcium carbonate, phosphoric acid, nitrogen, sulphur and organic matter, a portion of which is of asphaltic nature.

The original limestone has a fuel value equal to one fourth that of good coal. When properly prepared it forms a *compounding material* suitable for use in the production of black rubber goods.

The presence of notable quantities of plant food associated with the physical characters of the rock classifies it as an important soil maker, a fact proven by the rich grain fields of Syria.

CHAS. F. FOX: *An Improved Laboratory Burner.*

A description, illustrated by photograph, of a useful attachment (combined wind shield and crucible support) for laboratory burners.

J. CULVER HARTZELL: *The Correlation of Chemical, Structural and Thermal Analyses of Steels.*

In this paper the author presents the subject from the viewpoints of pure and applied science. In a recent trip which occupied several weeks, the author made a study of testing laboratories and heat-treatment plants and was impressed with the necessity of a better correlation of laboratory results with works results. Refinement of laboratory technic must be maintained; but there is need of better recognition of the limits of refinement in the hardening-room and high-speed-steel furnaces. While the latter should be brought up to and maintained at their highest efficiency, the refinement of the laboratory should not be expected; but the instructions sent down from the laboratory should contain reasonable working limits compatible with the best practical results obtainable.

E. LEHMAN JOHNSON: *If the Chemists Manufactured Cotton-seed Meal.*

If chemists, familiar with the need of balancing rations, had the exclusive manufacture of cotton-seed meal, instead of turning out a product altogether too rich, too concentrated, for ordinary feeding of any kind, as the southern cotton-oil mills are doing, they would make it in more sensible, more scientific fashion, more nearly like the cereals, corn and oats.

To insist, as some states already do and the national government is trying to do, upon compelling a high protein or nitrogen content of cotton-seed meal (higher than linseed meal, for instance) is an arbitrary abuse of power, good for neither producer, manufacturer or consumer. All three of these classes should look to the chemist for guidance in this matter, not to old habit or prejudice.

IRVING C. ALLEN: *The American Petroleum Society.*

IRVING C. ALLEN: *Flash Testing.*

HORACE C. PORTER and O. C. RALSTON: *A Study of the Oxidation of Coal and of the Process of Combustion.*

The rate of oxidation was studied for different kinds of coal at temperatures from 40° to 200° C. Large differences in rate were found which are in general parallel to the differences in inflammability and ease of ignition. The rapid increase of rate with rising temperature was shown. A study was made also of the products of oxidation, and evidence obtained which strongly supports the theory of the preliminary formation, in the early stage of combustion, of an addition complex of coal

with oxygen. This complex is unstable and decomposes by rise of temperature so as to form water, CO_2 and CO. Below 200° C. water is the principal product of the oxidation of coal. Carbon dioxide and carbon monoxide are formed in increasing amounts at 110° C. and above, by decomposition of the intermediate complex.

The bearing of the results on deterioration and spontaneous combustion, inflammability of coal dust, methods of analysis of coal, and problems of mine ventilation and mine fires is brought out.

DIVISION OF PHYSICAL AND INORGANIC CHEMISTRY

S. L. Bigelow, *Chairman*

R. C. Wells, *Secretary*

R. C. WELLS: *Observations on the Electrochemical Behavior of Minerals.*

It has been found that pyrite, which is a common constituent of most ore deposits, is capable of functioning to some extent as an unattackable electrode, so that chemical differences between solutions in ore deposits may be equalized through electrical action over appreciable distances as well as by direct mingling of the solutions. Such action would, however, require some sort of a liquid circuit in addition to the conducting mineral. A solution of sodium sulphide in contact with pyrite constitutes an anode combination of sufficient power to precipitate gold, silver, mercury and copper from their soluble salts upon a cathode of pyrite in an arrangement like a "chemometer." In fact, pyrrhotite and chalcocite in water alone suffice as anodes for the same purpose. The action of the more attackable minerals is due principally to their own solution-products so that the additional effects possible with unattackable electrodes are less marked.

EUGENE C. BINGHAM: *Fluidity and van der Waals's Equation.*

Batschinski[3] has proved that the fluidity ϕ of an unassociated liquid is a linear function of its volume (v) only, up to the critical temperature, *i. e.*, $v = \omega + c\phi$, where ω is a constant which is the sum of the atomic constants, and c is a constant which may be calculated. Substituting this value into the equation of van der Waals we obtain a relation between the fluidity of a liquid and the temperature and pressure

$$T = \frac{pk}{R}\phi + \frac{p}{R}(\omega - b) - \frac{a/Rc}{\phi + \omega/c} + \frac{ab}{R(\omega + c\phi)^2}$$

and all of these constants may be obtained without further viscosity measurements. Hence it is theoretically possible to calculate the fluidity of any non-associated liquid as soon as its expansion coefficients are sufficiently well known.

It can be shown that the above formula works out admirably in practise. Since in ordinary viscosity measurements, the pressure is constant and the last term of the equation may be neglected, we have

$$T = A\phi + C - \frac{B}{\phi + D},$$

where A, B, C and D are constants. An equation of this form will reproduce[4] the observed fluidities of the 85 substances measured by Thorpe and Rodger with a mean deviation for no substance equal to 0.1 per cent. In fact for most substances D may be made equal to zero, and satisfactory results obtained with the simple formula

$$T = A\phi + C - B/\phi.$$

The measurements of Phillips[5] confirm the view that the ϕ, p, T curves are similar to the familiar v, p, T curves up to the critical temperature. Beyond the critical temperature ϕ does not increase as the pressure is lowered, as is true of the volume. This leads to interesting and hitherto unnoticed relations between "collisional" and "diffusional" viscosity.

E. C. MCKELVY and F. A. WERTZ: *The Solubility of Water in Hydrocarbons.*

The critical solution temperature in certain systems of two liquids varies greatly with small additions of moisture. Solubility curves were determined for the systems methyl alcohol-turpentine, methyl alcohol-ligroin and ethyl alcohol-kerosene, with the dry hydrocarbons. The curves showing the variation of the maximum with small additions of water were then plotted. The hydrocarbons being saturated with water at any given temperature, the critical solution temperature found gives from these curves the amount of water dissolved in the oil. Calcium chloride was found to be most effective in drying the oils without otherwise changing their composition.

L. M. DENNIS and B. J. LEMON: *Electrolysis of Solutions of the Rare Earths.* (Lantern.)

WILDER D. BANCROFT: *Action of Light on Copper Sulphate Solution.*

WILDER D. BANCROFT: *Catalysis of Acetic Acid.*

E. C. MCKELVY: *The Critical Solution Temperature and Its Use in the Estimation of Moisture.*

The variation of the critical solution temperature of two liquids on the addition of a third com-

[3] *Ann. Soc. d'encourag. sciences exper.*, Supplement, *3*, 1913.

[4] *Zeitschr. f. phys. chem.*, *66*, 238 (1909).

[5] *Proc. Roy. Soc. London*, *87A*, 56 (1912).

ponent has had very little application in analytical chemistry. The solubility curve of the system ethyl alcohol-kerosene has been determined and the curve, showing the variation of the maximum with small additions of water, plotted. The change for 1 per cent. is 17.05°, but the variation is not quite linear. With careful manipulation the critical solution temperature can be determined repeatedly to 0.01° and so may be used to indicate a change of less than 0.001 per cent. in the water content of the alcohol. If the moisture in the substance to be examined can be transferred to anhydrous ethyl alcohol by some suitable means, a very delicate quantitative method is at hand. Since ethyl alcohol forms a mixture of minimum boiling point containing about 5.5 per cent. water, all alcohols, containing less than this amount of water, will tend to distil off between 78.0° and 78.3°. Distillation of the moist substance with anhydrous alcohol would be effective for the transfer of the moisture. Standing with the alcohol at room or higher temperatures might answer with certain substances. The method has been used in moisture determination in coal, wool, cotton, starch, sugar and offers possibilities in the examination of food products, soap, gelatin, shellac, oils, various textiles, etc.

George A. Perley and G. F. Lane: *The Analysis of Basic Lead Sulphates.*

Edgar T. Wherry: *Variations in the Compositions of Minerals.*

The old definition of a mineral species as a definite chemical compound is, in the light of recent work, no longer tenable. Instead it should be: a natural substance whose chemical and physical properties are constant within certain limits which vary considerably from one case to another. Colloid minerals may vary by reason of adsorption; meta-colloids (colloids which have become crystalloidal) and crystalline ones by isomorphous replacement, solid solution and sub-microscopic intergrowth. The group of ferric phosphate minerals is discussed as an illustration.

Payson Bartlett: *The Increase in the Oxidizing Potential of Dichromate Ion on Platinum Caused by Certain Reducing Agents. An Improved Method for the Electrometric Titration of Ferrous Salts.*

Certain reducing agents increase the oxidizing potential of the dichromate ion on platinum by amounts up to two tenths of a volt. No other oxidizing agent was found which would give a similar effect.

The potential continues to increase up to the very endpoint of the reaction and is highest when the dichromate concentration is least. A final drop of 0.1 normal reducing agent often depresses the potential by half a volt.

The duration of the effect varies with the reducing agent used from a few seconds to many hours. Chlorides are fatal to the permanency owing apparently to a side reaction.

The phenomenon may be plausibly explained by assumptions of catalytic action.

An improved apparatus and method for titrating dichromate and ferrous salts, based on the phenomenon, is suggested.

When the endpoint of this reaction is determined with a ferricyanide indicator, 0.0003 gram excess of ferrous iron in each hundred cubic centimeters of solution is present when the blue color barely develops within thirty seconds.

W. S. Hubbard: *Equilibrium between Pyridine, Silver Nitrate and Water.*

While working on a silver-plating bath where pyridine was used instead of cyanide, it was noticed that under certain conditions of concentration and temperature long silky, needle-shaped crystals separated out. Brewer[6] found that there were three well-defined compounds formed with pure pyridine and silver nitrate, but their description in no way resembles the one found in this case.

With 3 c.c. pyridine, 5 gm. silver nitrate and made up to 100 c.c. with water, the crystals form at 19.70° C. Using 4 c.c. of pyridine, they form at 25.35°, with 5 c.c. they separate at 27.35° and with 6 c.c. pyridine at 27.75°.

The exact composition has not been determined, but the method will be to determine the total nitrogen and nitrate nitrogen and then determine the silver electrolytically. The water can then be determined by difference or by drying in a desiccator since it thus loses its water of crystallization and becomes a fine powder. However, some of the pyridine might thus be lost.

Philip Adolph Kober: *New Precipitants for Copper.*

Two new precipitants for copper are proposed which form very insoluble compounds of copper (less than .6 part in one million remain unprecipitated). These are amino acids, phenylglycin and normal amino caproic acid which may be useful in estimating Fehling's and other solutions for unreduced copper and in removing copper quantitatively from substances which interfere with its idiometric titration.

[6] *J. Phys. Chem.*, 12, 283.

E. W. WASHBURN and S. J. BATES: *The Electrochemical Equivalent of Iodine and the Value of the Faraday.*

H. C. P. WEBER: *The Reduction of Chromium Chloride.*

T. W. B. WELSH and H. J. BRODERSON: *Anhydrous Hydrazine as a Solvent.* (Presented by A. W. BROWNE.)

The solubility of 120 elements and compounds in anhydrous hydrazine was studied. Of the metallic elements employed, the alkali metals are the only ones appreciably acted upon and dissolved. The solubility of the halogen compounds increases with increase in the atomic weight of the halogen. The chlorides of the alkali metals are the least soluble. Carbonates and oxides are, as a rule, insoluble. Nitrates are generally soluble. Sulphates and sulphides are insoluble. Ammonium compounds are soluble with the exception of the tertiary phosphate. The solution of ammonium salts is accompanied by *hydrazinolysis* with evolution of ammonia. A large number of compounds dissolve, and at the same time react with the solvent.

T. W. B. WELSH and H. J. BRODERSON: *Chemical Reactions in Anhydrous Hydrazine.* (Presented by A. W. BROWNE.)

Metathetical reactions take place between soluble salts of zinc, or cadmium, and hydrazine sulphide, with formation of the metallic sulphides. In fact, solutions of these salts in anhydrous hydrazine may be titrated with solutions of hydrazine sulphide, using the brownish-yellow color of the latter as indicator. By the action of the *hydrazo-base,* sodium hydrazide, upon zinc chloride in hydrazine solution, a solid which is in all probability zinc hydrazide, is precipitated. Hydrazo-bases are neutralized in hydrazine solution by hydrazine salts, which under these conditions act as acids. For example, sodium hydrazide reacts with hydrazine chloride, yielding sodium chloride and hydrazine. Metallic sodium will precipitate metallic cadmium, zinc and iron, from solutions of their salts.

T. W. B. WELSH: *Electrolysis of Solutions of Sodium Hydrazide in Anhydrous Hydrazine.* (Presented by A. W. BROWNE.)

Solutions of sodium hydrazide (prepared by the action of either sodium amide or metallic sodium upon hydrazine) in anhydrous hydrazine have been electrolyzed, in absence of air and moisture, under such conditions as to permit measurement and analysis of the gases evolved at the electrodes. In general nitrogen and hydrogen were obtained at both electrodes. For each gram atom of copper deposited on the coulometer cathode, from 1.1 to 1.5 gram atoms of nitrogen were liberated at the anode when the electrolyte was dilute, and from 2.1 to 2.6 when the concentration was higher. A blue color due to metallic sodium was in some experiments transitorily observed at the cathode. A characteristic yellow coloration was (reversibly) obtained in the neighborhood of the cathode.

A. R. HITCH: *Electrolysis of Silver Trinitride in Liquid Ammonia.*

A. R. HITCH: *Thermal Decomposition of Various Trinitrides.*

HAROLD EATON RIEGGER: *The System Hydrazine Trinitride, Hydrazine.* (Presented by A. W. BROWNE.)

It has been found possible to prepare hydrazine trinitride (first prepared by Curtius) by each of three methods: (*a*) Interaction of anhydrous hydrazine and ammonium trinitride, (*b*) interaction of anhydrous hydrazine and anhydrous hydrogen trinitride, and (*c*) interaction of alcoholic hydrazine and ethereal hydronitric acid. A convenient method for the analysis of the compound has been formulated, and certain of its properties and reactions have been studied, including the behavior of the substance when heated in a sealed tube to 100°. The substance is very soluble in anhydrous hydrazine, and soon deliquesces when exposed to hydrazine vapor. A study of the solubility (*T*, *X*) curve for the system hydrazine trinitride; hydrazine yielded results that point toward the existence of a monohydrazinate of the formula $N_2H_5N_3 \cdot N_2H_4$, and to the probable existence of at least one higher hydrazinate.

W. J. MARSH: *Action of Various Oxidizing Agents upon Hydrazine in Liquid Ammonia Solution.*

The behavior of free hydrazine in liquid ammonia at —33° toward potassium permanganate, manganese dioxide, mercuric oxide (yellow), ammonium persulphate, sodium peroxide, ferric oxide, potassium chlorate, potassium iodate and ammonium perchlorate, respectively, has been studied with the aid of a modified nitrometer. All but the last three of these substances oxidize the hydrazine more or less rapidly, with formation of nitrogen and water as the oxidation products. Potassium permanganate is quantitatively reduced to manganous hydroxide and potassium hydroxide. In several cases the gas was evolved in two distinct

stages, the second stage occurring at a temperature somewhat above —33°. This may be attributable to the decomposition in successive stages of the oxidizing agent used, or possibly to the formation and subsequent decomposition of certain complex hydronitrogens as unstable intermediate products.

Fritz Friedrichs: *Critical Phenomena in Binary Systems.* (Presented by A. W. Browne.)

Fritz Friedrichs, A. E. Houlehan and L. J. Ulrich: *The System Ammonium Sulphate, Ammonia.* (Presented by A. W. Browne.)

Fritz Friedrichs: *The System Mercuric Chloride, Ammonia.* (Presented by A. W. Browne.)

L. J. Ulrich: *The System Ammonium Iodide, Ammonia.* (Presented by A. W. Browne.)

G. J. Fink: *The System Ammonium Chloride, Ammonia.* (Presented by A. W. Browne.)

G. J. Fink: *The System Copper Sulphate, Ammonia.* (Presented by A. W. Browne.)

A. S. Yount: *The System Silver Trinitride, Ammonia.* (Presented by A. W. Browne.)

J. W. Turrentine: *The Structure of the Trinitride Radicle.*

Symposium on Photographic Chemistry

This symposium was held at Kodak Park. Papers were presented as follows:

Geo. A. Perley: *The Production of Direct Photographic Positions.*

P. G. Nutting: *Practical Sensitometry.*

Photography sensitometry is the determination of the relation between blackening and exposure. Blackening is measured as density $D = -\log$ transmission. Exposure is properly in ergs per sq. cm. of a specific wave-length but in meter-candle-seconds involving properties of the eye. The Hurter and Driffield curve, density against log exposure gives the two chief characteristics—speed and contrast sensibility. Plates are fast or slow, hard or soft working according to the shape of this curve.

Works tests are made by printing through a tablet of gray and colored squares of graduated density. Laboratory tests are made by exposure to a standard white light behind a rotating sectored disk giving exposures of 1, 2, 4, 8 . . . 256, M-C-S. Densities are measured on a special photometer. High precision sensitometry requires many refinements of coating, exposure, development, etc.

S. E. Sheppard: *Some Applications of Quantitative Absorption Spectroscopy in Chemistry.*

Making use of the relations:

(i) $I_\lambda = I_0 a^{cd}$ (Beer-Lambert law), where $I_\lambda =$ intensity of monochromatic light wave-length λ transmitted by an absorbing layer of thickness d cm., and of concentration c in grammes per liter, $I_0 =$ intensity of light incident on same, $a =$ a constant, the transmission-coefficient.

(ii) $M = C/a$ (Vierodt's equation), where $M =$ molecular absorption ratio,
$C =$ concentration in gram-molecules per liter,
$a =$ transmission-coefficient of (i).

Then the absorption of light can be determined quantitatively in regard to both color (wave-length of light waves) and concentration of reacting molecules. The principal applications considered were as under:

(*a*) Analytical determination of amounts of dyestuffs and colored salts in solutions.

(*b*) Technical: adjustment of ray-filters.

(*c*) Theoretical: application to problems of molecular constitution, of "solutions" and of photo-chemical change.

L. A. Jones: *Some Notes on the Cylindrical Acetylene Flame as a Standard of Light.*

A good reliable standard light source is a necessity in photographic sensitometry. The old-style acetylene flame is not very satisfactory for this purpose, on account of its sensitiveness to air currents and the liability to parallax errors. A newer type of standard acetylene burner designed by Dr. Mees and Dr. Sheppard gives a cylindrical flame much more steady and reliable than the flat flame.

Careful photometric measurements made on this improved burner show that when properly adjusted the intensity of light is constant even when the gas pressure varies considerably. The results indicate also that with proper care in construction, especially in the width of slit used as screening diaphragm, different burners can be made that will give the same light intensities to within 3 or 4 per cent.

The investigation is not complete as yet, but unless unexpected difficulties arise, this form of burner will undoubtedly be found very satisfactory as a standard light source for sensitometric work.

Orim Tugman: *The Sensitiveness Curves of Photographic Plates Exposed to X-Rays.*

According to the equation given by Hurter and Driffield for the relation between the exposure and the development density in photographic plates the density of a plate exposed to X-rays should be directly proportional to exposure because the ca-

pacity of the film to X-rays is negligibly small.

A series of exposures of three kinds of plates (Seed 23, 30 and X-ray) to light and X-rays have been made to determine this point. In all the fifteen exposures to X-rays the curves showing density against log exposure were practically similar to the curves obtained by light exposure. The equation

$$D = \gamma \ (\log E - \log i)$$

was found to fit the straight part of the curves as well as for light curves.

A. S. McDANIEL: *The Theory of the Acid Fixing Bath.*

The amount and nature of free acid which can be added to a thiosulphate fixing bath is shown to be dependent upon the equilibrium conditions of either or both of the following reversible reactions, one of which takes place between ionized, the other between undissociated molecules:

(1) $S_2''O_3 + H \cdot \rightleftarrows HSO_3' + S,$

(2) $Na_2S_2O_3 + 2HX \rightleftarrows 2NaX + N_2SO_3 + S.$

According to equation (1) the absolute concentration of the hydrogen ions can be increased only by increasing the concentration of the HSO_3 ions at the same rate. Similarly, according to equation (2) the absolute concentration of acid can be increased only by keeping the ratio of the concentration of H_2SO_3 to HX above a certain definite limit, depending upon the solubility of sulphur.

In practise these conditions are fulfilled by adding sulphurous acid or a mixture acid or a mixture of sulphite and acid to the bath.

WILDER D. BANCROFT: *The Latent Image.*

WILDER D. BANCROFT: *Theory of Developer.*

G. B. FRANKFORTER and W. KRITCHEVSKY: *The Action of Chloral and Bromal on the Polycyclic Hydrocarbons in the Presence of Aluminium Chloride.*

G. B. FRANKFORTER and E. B. DANIELS: *The Action of Aluminium Chloride on Aliphatic Ethers.*

DIVISION OF FERTILIZER CHEMISTRY

Paul Rudnick, *Chairman*

J. E. Breckenbridge, *Secretary*

PAUL RUDNICK: *Chairman's Address. Fertilizer Chemistry. A Report of Progress.*

L. A. WATT and W. T. LATSHAW: *On the Use of Alundum Crucibles in the Determination of Phosphoric Acid.*

H. W. HILL and W. S. LANDIS: *The Analysis of Complete Fertilizers Containing Cyanamid.*

PAUL RUDNICK and W. L. LATSHAW: *On the Preparation of Neutral Ammonium Citrate Solution.*

SECTION OF INDIA RUBBER CHEMISTRY

D. A. Cutler, *Chairman*

Dorris Whipple, *Secretary*

D. A. CUTLER: *Chairman's Address. Crude Rubber.*

G. H. SAVAGE: *Some Refinements of the Ignition Method for the Determination of Rubber in Vulcanized Goods.*

WATER SEWAGE AND SANITATION SECTION

Edward Bartow, *Chairman*

HARRY P. CORSON, *Secretary*

EDWARD BARTOW and H. P. CORSON: *Manganese in Illinois Waters.*

The city supplies of Mt. Vernon and Peoria, Ill., contain manganese which has caused serious incrustation in pipes. The Mt. Vernon supply contains .5 part per million of the element while the wells of the Peoria supply contain from .02 to 1.2 parts per million of the element. Samples of incrustation examined contain as high as 38 per cent. of manganese.

EDWARD BARTOW and CLARENCE SCHOOL: *A Comparison of a Calcium Lime with a Calcium-Magnesium Lime for Water Softening.*

Experiments show that during the various stages of water softening there is a difference in the action of a calcium lime and a magnesium-calcium lime. Complete softening depends upon the amount of available calcium oxide which the lime contains.

EDWARD BARTOW and CLARENCE SCHOOL: *The Order of Reactions during the Softening of Water with Lime.*

CHARLES BASKERVILLE: *Ventilation of the Schools of New York City.* (Illustrated.)

FRANK E. HALE and W. MELIA: *Winkler's Method for the Determination of Oxygen in Water; the Effect of Nitrite and its Prevention.*

H. W. REDFIELD and C. HUCKLE: *A Comparative Study of Methods for Determining Sulphur in Peptone.*

Various methods for determining the total sulphur in peptone and for determining a part of the sulphur only have been compared.

For total sulphur the Liebig-Koch method has been found to give the most accurate and most consistent results in peptone; while for determining the easily oxidized part of the sulphur, digestion with a saturated solution of potassium chlorate in nitric acid has proved most valuable.

H. W. REDFIELD and C. HUCKLE: *The Determination of Sulphur in Certain Culture Media.*

A study has been made of the amount of total

sulphur broken down in simple peptone media by the so-called putrefactive bacteria, of the forms of sulphur most readily used by them and of the forms in which the sulphur exists after the action of the bacteria, whether as fixed sulphur, or as loosely bound sulphur, or as easily oxidized sulphur, or as a volatile sulphur compound such as hydrogen sulphide, when culture flasks of different size and shape were used and when air or carbon dioxide was passed over the cultures.

E. M. Chamot: *The Value of Testing for Hydrogen Sulphide Production in the Bacteriological Examination of Potable Waters.*

E. M. Chamot and H. W. Redfield: *A Study of the Best Conditions for Hydrogen Sulphide Production in Peptone Media.*

The method for the detection in water of the bacteria producing hydrogen sulphide has been studied in a systematic manner as regards the concentration of possible ingredients, and a culture medium has been devised by the use of which the time required in which to get evidence of the presence of these organisms has been greatly reduced.

The method furnishes a means of detecting certain organisms which do not produce gas in lactose media, but which are found in sewage-polluted water.

E. M. Chamot and R. C. Lowary: *The Influence of the Composition of Carbohydrate Culture Media on the Amount and Character of the Gases formed by Fecal Organisms.*

E. M. Chamot and C. M. Sherwood: *A Study of the Stokes Neutral Red Reaction.*

J. Culver Hartzell: *Further Notes on Standards of Potable Waters.*

In this paper the author states that he has collected further data on the necessity for regional standards of potable waters, and that the feeling is growing that standards are not only possible and desirable, but necessary.

Atherton Seidell and Philip W. Meserve: *The Determination of Minute Amounts of Sulphur Dioxide in Air.*

The amounts of sulphur dioxide which it was desired to determine varied from about 1 to 15 parts per million, which is about the concentration just detectible by the odor. Experiments showed that at this dilution, various modifications of the iodine titration methods, involving the use of an excess of iodine and back titration directly or with an excess of thiosulphate and then to appearance of the blue starch color with iodine, were impractical on account of the variability of the end point when approached in opposite directions. It was found that satisfactory results could be obtained by adding about 5 c.c. of water containing starch paste to the 2,500 c.c. bottle containing the sample and titrating to appearance of the blue starch color with $N/1{,}000$ iodine. A correction for the blank determination in the bottle containing air free from sulphur dioxide, and one for the apparent incompleteness of the reaction at this dilution must be applied. With these corrections for a 2,500 c.c. bottle, 1 c.c. of $N/1{,}000$ iodine corresponds to 4.1 parts SO_2 per million. On account of the rapid oxidation of SO_2 to SO_3, even in bottles as dry as can conveniently be obtained, it is necessary to make the titrations within a short time after collecting the samples. When relatively minute amounts of SO_2 are liberated in rooms and the air actively stirred, less than one half the calculated percentage in the air has so far been found. The complete disappearance of the liberated SO_2 may occur in less than one half hour, depending upon the amount of moisture, nature of walls, etc.

J. W. Sale and W. W. Skinner: *Comparison of Methods for the Determination of Dissolved Oxygen.*

A comparison of the Winkler and modified Levy methods with the gasometric method for the determination of dissolved oxygen indicates that in pure and moderately polluted saline waters the Winkler method gives accurate results while the Levy method gives results that are too low. The Winkler method also gives closely agreeing results in duplicate and triplicate determinations on such waters, for the most part within .02 c.c. oxygen per liter. Only that modification of the Levy method in which sodium carbonate is used to precipitate the iron salts was compared.

W. D. Collins and W. W. Skinner: *The Quantitative Use of the Spectroscope in Water Analyses.*

By careful attention to details of manipulation described in the paper quantitative results for lithium and potassium may be obtained by use of the spectroscope in very much less time than is required for separation of the alkalies in a water analysis. The errors may be 5–10 per cent. of the amounts determined. The results in connection with other quickly made determinations make possible the furnishing of a fairly complete water analysis with a comparatively small amount of work.

F. L. Rector: *Longevity of B. Typhosus in Water.*

Charles L. Parsons,
Secretary